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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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VOLUME 57 **AUGUST 1954** NUMBER 680

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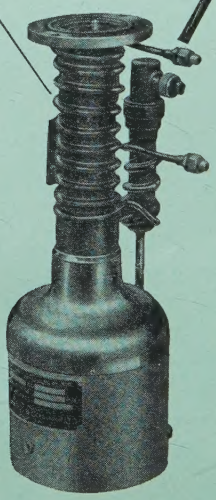

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Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953) an the Supplement published with the Index to Volume 56 (1953). Reprints of the List of Journals (1953) and th Supplement (1953) can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, pri 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted f errors.

New Journal

J. Assoc. Comput. Machin. — *Journal of the Association for Computing Machinery.* 2 East 63rd St., Ne York 21, N.Y. Published quarterly. Volume 1, Number 1 dated *Januar* 1954. Subscription $10, single copies $2.50.

Note

Zh. éksper. teor. Fiz.
Zh. tekh. Fiz.

Enquiries relating to the 1953 issues of these two journals (Volumes 24 and 2 of the former, and Volume 23 of the latter), abstracted in this and subseque issues of *Science Abstracts*, should be directed to Technical Informatic Service, Department of Scientific and Industrial Research, Charles Hous 5–11 Regent St., London, S.W.1.

Errata

Abstr. 9088 (1952), line 3: *for* **20** *read* **23.**

Abstr. 302 (1954), line 3: *for* C. DRUMMOND *read* G. DRUMMOND.

Abstr. 3933 (1954), line 3: *for* C. BOATO *read* G. BOATO.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unle otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which t original article was published.

Abstr. 3303 (1954): **9a**, 476 (*May*, 1954).

Abstr. 3376 (1954): **22**, 1145 (*June*, 1954).

Abstr. 3454 (1954): **22**, 1144–5 (*June*, 1954).

MATHEMATICS 51

513.3

7063. Solid angle subtended by a circular aperture at point and spread sources: formulas and some tables. A. H. JAFFEY. *Rev. sci. Instrum.*, **25**, 349–54 (*April*, 1954).

Some formulae for calculation are presented, and three tables of solid angle values. A.

517.4 : 539.132

A property of "repeating" secular determinants. *See Abstr.* 7629

517.5

7064. Generalization of the Wiener-Khintchine theorem to nonstationary processes. D. G. LAMPARD. *J. appl. Phys.*, **25**, 802–3 (*June*, 1954).

The Wiener–Khintchine theorem which connects the autocorrelation function and the power spectrum of a stationary time series by means of a Fourier cosine transform is well known. It is the purpose of this paper to generalize the theorem to deal with non-stationary time series. A.

517.5 : 530.145 : 519.2

7065. Application of the δ-function to the micro-canonical content. A. MÜNSTER. *Z. Phys.*, **137**, *No.* 3, 386–91 (1954) *In German.*

The theory of the microcanonical content is simplified by the use of the Dirac δ-function. The statistical analogues of entropy and absolute temperature are considered. L. S. GODDARD

517.75

7066. A transform method for linear time-varying systems. J. A. ASELTINE. *J. appl. Phys.*, **25**, 761–4 (*June*, 1954).

Discusses a method for finding an integral transformation applicable to certain time-varying systems. Examples of transformations derived by the method, including Laplace, Mellin, and Meijer, are given. A convolution theorem for the general method is presented, and its use in general representation of time-varying systems is illustrated. A.

518.1

7067. On the evaluation of the operator function log $(e^y e^z)$. I. FUJIWARA. Letter in *Progr. theor. Phys.*, **9**, 676 (*June*, 1953).

The evaluation, for two arbitrary non-commuting operators y and z, is effected by putting $\log(e^y e^z) = e^{-u} y e^u$, where the auxiliary operator u has to satisfy the two conditions $[z, u] = 0$ and $[e^y, u] = e^y z$. G. FIELD

518.2

7068. Royal Society depository for unpublished mathematical tables. *Phil. Mag.*, **45**, 599–609 (*June*, 1954).

In 1951 the Royal Society established a depository for unpublished mathematical tables. A list is given of the 41 tables accepted up to the end of 1953 together with a brief description of each. The tables may be consulted in the Library of the Royal Society and photocopies may be prepared at the expense of those who desire them. A.

518.2

7069. Tables of secants and cosecants to nine significant figures at hundredths of a degree. *Appl. Math. Ser. Nat. Bur. Stand., No.* 40, 46 *pp.* (1954).

Derived from *Tables of sines and cosines to fifteen decimal places* [Abstr. 5860 (1949)]. G. J. KYNCH

518.2

7070. Tables of 10^x (antilogarithms to the base 10). *Appl. Math. Ser. Nat. Bur. Stand., No.* 27, 543 *pp.* (1953).

There is a main table, $x = 0(\cdot 00001)1$, to 10 decimal places. An auxiliary table of $10^{n(10^{-p})}$, $n = 1(1)999$, $p = 3, 6, 9, 12, 15$ (15 decimal places, enables the quick calculation of antilogarithms of 15 figure numbers to about 15 decimal places, or significant figures. The main table is based on that of Dodgson (Antilogarithmic Canon, 1742).

G. J. KYNCH

518.5 : 621.3.011

7071. Solutions of boundary-value problems on automatic computing equipment. F. M. VERZUH. *Commun. and Electronics, No.* 10, 813–21 (*Jan.*, 1954).

The trial-and-error method was found to be the most amenable for the solution of boundary value problems (conditions being prescribed at points other than the origin) on various types of automatic computers of the digital and of the analogue type, as well as by a desk calculator. Solutions of the Schroedinger equation are compared for the various cases, with regard to method, number of points and decimal digits, and solution time. The author gives a brief assessment which takes account of the time spent in preparing the problem for the machine. T. J. REY (R)

519.271

7072. Introduction to the theory of error. Y. BEERS. *Cambridge, Massachusetts: Addison-Wesley Publishing Company*, 65 + vi *pp.*

Review in *Rev. sci. Instrum.*, **25**, 380 (*April*, 1954).

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.53 : 535.514

7073. The diameter of the satellites of Jupiter, of Titan and Neptune, determined by the doubly refractive micrometer with a high-power separator. A. DOLLFUS. *C.R. Acad. Sci.* [*Paris*] **238**, 1475–7 (*April* 5, 1954) *In French.*

Describes the improvement in definition of star images by the use of the double-image micrometer,

giving higher precision to measurements. Gives results of measurements made with the 24 in. refractor on the Pic du Midi, attaining separations of 0·2″. The existence of spotted areas on some of the satellites reduces the accuracy but the results of some 30 nights' work compare favourably with earlier quoted work.

E. G. MARTIN

523.161

7074. Aerodynamic motions of interstellar gas clouds. G. C. McVittie. *Astrophys. J.*, **119**, 352–64 (*March*, 1954).

A new method for solving the equations of gas dynamics, which depends on the Newtonian approximation to Einstein's equations of general relativity, is described for the case of one-dimensional motion. The resulting equations take account of the pressure-gradient force in the gas and of the force due to the gravitational self-attraction of the mass of gas under consideration. The motion of a thin interstellar cloud, bounded by two parallel planes that are shock waves and moving perpendicularly to these planes, is considered. It is shown that such a cloud can move as an entity held together by its gravitational self-attraction. The motion may be either with constant velocity or subject to an acceleration that is either constant or varies with the time. Outside the cloud, there may be either a vacuum or a gas at relatively low density. When the velocity is either constant or subject to a constant acceleration, adiabatic motion of the cloud is possible. When the acceleration varies with the time, the cloud may be losing energy by radiation. The width of the cloud, in the direction of its motion, is calculable in terms of the density and temperature at the densest portion of the cloud. Numerical values for the widths range from 45 to ½ parsecs, according to the circumstances postulated at the densest portion. A.

523.165 : 537.591.1

7075. On the origin of cosmic rays. I. S. Shklovskiĭ. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 3, 475–8 (1953) *In Russian.*

It is pointed out that the radio radiation from novae and supernovae can be accounted for by the bremsstrahlung of relativistic electrons if fields of $\sim 10^{-4}$ gauss are available in the turbulences accompanying the explosions. The rate of energy radiation from such explosions is just of the order required to keep the intensity of cosmic radiation at its present level in our galaxy. The importance of radio astronomy for the question of the origin of cosmic rays is stressed. The absence of radio radiation and the low frequency of novae in the Magellanic Clouds is pointed out.

W. J. SWIATECKI

523.165 : 537.591.1 : 523.841.11

7076. Supernovae and novae as sources of cosmic and radio radiation. V. L. Ginzburg. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 6, 1133–6 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-230.

Order of magnitude estimates of the energy flux at visible and radio wavelengths to be expected from bremsstrahlung of relativistic electrons in magnetic fields associated with novae and supernovae. Comparison with data on supernovae of A.D. 369, 1054, 1572.

W. J. SWIATECKI

523.165 : 551.510.535

A radio astronomical investigation of drift movements in the upper atmosphere. *See Abstr.* 7912

523.72

7077. On some features of noise storms. T. Hatanaka and F. Moriyama. *Rep. Ionosphere Res. Japan*, **6**, 99–109 (*June*, 1952).

Observations of noise storms of the solar radio emission on metre wavelengths are analysed. A noise storm seems to occur in a sporadic manner in a region above a large and magnetically active sunspot. The probability of a storm being observed is maximum at the time of the central meridian passage of the spot and falls off to half-value in 2 days from it. An intense flare which accompanies a non-polarized outburst seems to act as the exciting mode of a storm. The storm decays exponentially, the time constant being 15–30 min. A right-handed circularly polarized storm is associated with the south pole of a sunspot and vice versa. A.

523.72

7078. Three most intense solar noise bursts on a wave-length of 10·7 centimetres. A. E. Covington. *J. Roy. Astron. Soc. Canada*, **47**, 106–8 (*May–June*, 1953).

The three most intense solar noise bursts recorded on a wavelength of 10·7 cm at Ottawa are shown graphically. These are from a collection of 432 bursts which occurred during 11 700 hours of observations in the years 1947 to 1952 inclusive. In each case the peak flux $>1\cdot7\times10^{-19}$ W/m² per c/s. A.

523.72 : 523.877

7079. The statistical mechanism of the acceleration of particles on the sun and in stellar shells. V. L. Ginzburg. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 4, 727–30 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-207.

The high efficiency for the acceleration of particles on the sun and in stellar shells of the statistical mechanism (proposed by Fermi in 1949 for collisions with turbulences in interstellar space) is pointed out. In a time of the order of some hours a particle in a prominence on the sun could reach relativistic velocities. The necessary injection energies for protons and electrons are estimated.

W. J. SWIATECKI

523.74

7080. A new theory of solar granulation. II. Propagation in an isothermal atmosphere. E. Schatzman. Letter in *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 2, 139–42 (1954) *In French.*

A continuation of the investigation described previously [Abstr. 6232 (1954)]. The mathematical analysis is extended to explain the formation of spherical "granules" by the passage of a plane compression wave through the isothermal region of the solar photosphere.

D. R. BARBER

523.746

7081. Radiation flux in sunspot umbrae. II. A. S. Ramanathan. *Z. Astrophys.*, **34**, *No.* 3, 169–72 (1954).

For Pt I, see Abstr. 6424 (1953). The ratio of umbral intensity to photospheric intensity as a function of wavelength has been studied in the case of four

fairly large spots in the wavelength range 4000 Å–6500 Å. The relative spectrophotometric gradient has been evaluated for each spot. A.

523.746

7082. The proper motion of sunspots in latitude. U. BECKER. *Z. Astrophys.*, **34**, *No.* 2, 129–36 (1954) *In German.*

A re-examination of Tuominen's work [Abstr. 6250 (1952)] and that of Richardson and Schwarzschild [*Publ. Accad. Naz. dei Lincei, Fondazione Allesandro Volta, Atti dei Convegni*, **11**, 228–49 (1953)]. The motion of the spots is not only a function of their heliographic latitude but it also depends on the actual latitude position of the spot-zone; the centre of the latter is shown to be at the boundary between the polar and the equatorial direction of motions. It is not necessary to postulate a dependence on the 22-year cycle of the magnetic spot-polarity. A. BEER

523.75 : 537.591.5

7083. Solar magnetic moment and cosmic-ray effects associated with solar flares. S. B. TREIMAN. *Phys. Rev.*, **94**, 1029–30 (*May* 15, 1954).

A close correlation between solar flares and small cosmic-ray intensity increases has recently been established by the Climax, Colorado neutron monitor data. The correlation, however, is restricted only to those flares which occur when the station lies within a certain interval of local solar time. This has been explained by supposing that the new cosmic-ray particles approach the earth preferentially along the earth–sun line, before deflection in the terrestrial magnetic field takes place. In the present paper, this evidence is used to establish an upper limit to a possible solar magnetic dipole field. Allowance is made for the fact that the dipole field may be seriously perturbed by local fields near the sun; but on the assumption that the dipole field predominates far from the sun (at distances greater than one-fifth the earth–sun distance), the upper limit on the solar dipole moment is 5×10^{32} gauss cm^3. A.

523.755

7084. Asymmetry of coronal jets with respect to the solar meridian. M. TRELLIS. *C.R. Acad. Sci.* [*Paris*] **238**, 875–7 (*Feb.* 22, 1954) *In French.*

Using intensity measurements of the coronal line 5303 Å from spectra of the inner corona obtained at Pic du Midi, 1945–52, it is shown that a lack of symmetry of the observed (apparent) isophotes exists relative to the point of max. intensity which is interpreted as a result of an unsymmetrical distribution of real coronal intensity at the solar surface. Such eccentricity of the jet isophotes about the position of max. intensity suggests a spatial inclination of the jet stream relative to the solar meridian plane. A significant variation of the observed asymmetry with latitude has been found also. D. R. BARBER

523.77

7085. Fraunhofer lines in an inhomogeneous magnetic field. H. HUBENET. *Z. Astrophys.*, **34**, *No.* 2, 110–28 (1954) *In German.*

The theoretical expressions for the profiles are derived. It is shown that the equivalent width is independent of the magnetic field-strength in the case of a normal Zeeman effect with a homogeneous longitudinal field. An application is made to a simplified treatment of the FeI line λ6173 in a spot at the sun's centre, with a purely longitudinal field decreasing outwards, and using Waldmeier's model for the spot. The calculated profiles of the components of the line exhibit certain asymmetries, due to the gradients of the field, and their empirical check with methods of photoelectric photometry is suggested. A. BEER

523.77

7086. Identification of the atom responsible for the coronal line at λ5694·4. C. PECKER, D. E. BILLINGS AND W. O. ROBERTS. *C.R. Acad. Sci.* [*Paris*] **238**, 1101–3 (*March* 8, 1954) *In French.*

B. Edlén [*Z. Astrophys.*, **22**, 30 (1942)] proposed as the identification of this radiation the transition ($2s^2 2p^2\ ^3P_1 - {}^3P_0$) of Ca XV; this caused objections by other investigators. The present study is based on numerous spectrograms obtained at the coronograph station at Climax, Colorado which, in the first instance, were aimed at establishing the atomic weight of the responsible element. This turned out to be around 40, i.e. close to two elements both of which contribute to the radiation of the corona, namely Ca (40·1) and A (39·9). In addition, a study was made on these spectra of the line 5446·5 Å [discovered by Waldmeier, *Z. Astrophys.*, **29**, 29 (1951)], which appeared to belong to the same group as 5694. The line profiles of the Climax spectra confirm this and lead to an approximate intensity ratio 5694/5446 $\simeq$ 1·6. They support the view that everything is now in favour of Edlén's original classification. Certain difficult points remain, however, e.g. the deviation of Garstang's [Abstr. 8643 (1952)] theoretically predicted wavelengths from these newly observed ones; furthermore, the question as to how this high ionization potential of Ca XV (814 volts) can be achieved in the same coronal region which shows the red and the green lines with only 233 and 355 volts, respectively. A. BEER

523.77

7087. A study of the broadening of the red coronal line in active centres. D. E. BILLINGS, C. PECKER AND W. O. ROBERTS. *C.R. Acad. Sci.* [*Paris*], **238**, 1194–6 (*March* 15, 1954) *In French.*

Temperatures computed from Doppler half-width data for the coronal emission line at 6374 Å, observed over active and quiescent regions of the sun, yield excess values of from 1×10^6 to 1×10^7°K which appear associated with abnormally disturbed conditions. Results from observations on 8 dates when solar activity was enhanced are tabulated. T excess temperature values are referred to a mean coronal temperature of $2 \cdot 3 \times 10^6$°K for a "quiet" sun, corresponding to an observed half-width of 0·92 Å. D. R. BARBER

523.87

7088. The doublet 6548–6584 Å of [NII] in interstellar emission. G. COURTÈS. *C.R. Acad. Sci.* [*Paris*] **238**, 877–9 (*Feb.* 22, 1954) *In French.*

In order to obtain a correct value for the emission

intensity at H_α(6562 Å) observed in planetary and gaseous nebulae, correction is necessary for the nearby emission due to [NII] at 6548, 6584 Å which is also transmitted by the narrow-band selective filters usually employed. To do this a knowledge of the intensity ratio, [NII]/H_α is required, being obtainable either from spectrophotometric measurements in high-dispersion spectra, or by an interferometric method as in the present investigation. In the latter event, the retardation of the etalon employed is so chosen that the ring systems from the two [NII] lines are superposed and recorded between those due to H_α, the separation being between 200 and 500 μ on the photographic plate. Observations of 9 different nebulae show that the [NII]/H_α ratio is very variable, even from point to point in the same nebular field.

D. R. BARBER

523.87

7089. Measurement of the energy distribution in the continuous spectrum of six planetary nebulae. D. BARBIER AND H. ANDRILLAT. *C.R. Acad. Sci.* [*Paris*] **238,** 1099–100 (*March* 8, 1954) *In French.*

This investigation (carried out with a *f*/2 quartz spectrograph attached to the 80 cm telescope of the Observatoire de Haute Provence) applies essentially the spectrophotometric method developed in previous years by Barbier (1944) in his measurements of the Orion nebula. The nucleus of the nebulae was kept outside the spectrograph slit; the range of the wavelengths used was between 3450–3650 Å and 4000–4550 Å. One of the nebulae exhibits some deviations from the theory of the nebular continuum by Spitzer and Greenstein (1951). This theory is also applied to the derivation of electron temperatures, which are judged by the authors to be the most certain of their observational results. A. BEER

523.872

7090. Radiative opacity of stellar matter. H. ZIRIN. *Astrophys. J.*, **119,** 371–85 (*March*, 1954).

The wave-functions of free and bound electrons in the dense, highly ionized stellar material are calculated by a variational principle of Hulthen and by the Ritz principle, respectively. It is shown by a self-consistent type of calculation that one may regard the potential in the gas as the central potential of the nucleus, plus the potential of a uniformly distributed cloud of electrons. The free-free absorption in this shielded potential is calculated, and the Gaunt factor for this process is found to be generally less than unity. The Rosseland mean opacity coefficient is computed for a grid of temperatures and densities, including the free-free absorption, photoelectric absorption (using Meyerott's cross-sections), and scattering. The line absorption is not taken into account. It is found that free-free absorption in hydrogen and helium overweighs that in the heavy elements, so long as $1 - X - Y$ is 0·2 or less. It is possible to give a power law only for the opacity in the limited high-density region where scattering is unimportant; there the opacity varies as $T^{-2\cdot9}$, but the density variation is always irregular. A.

523.872

7091. The Gaunt factor for free–free transitions in pure hydrogen. R. M. KULSRUD. *Astrophys. J.*, **119,** 386–92 (*March*, 1954).

The Gaunt factor for free–free transitions of an electron in the interior of a star, assuming pure hydrogen, is computed, taking into account the overlapping of the Coulomb fields of the hydrogen ions. It is found that the results originally obtained by Sommerfeld for the case of a pure Coulomb field must be altered by changing the normalization of his electronic wave-functions at infinity. A simple analytic expression is found for the Gaunt factor, and its average over the Maxwell distribution of the initial velocities is carried out. A.

523.877.

7092. On the equilibrium of magnetic stars. V. C. A. FERRARO. *Astrophys. J.*, **119,** 407–12 (*March*, 1954).

The necessary condition for the equilibrium of a liquid magnetic star is derived and the solution in a particular case given. It is shown, as was first pointed out by Chandrasekhar and Fermi, that a magnetic field has the same effect as rotation, i.e. it tends to produce a flattening of the poles of the star. A formula for the ellipticity is derived. A.

523.877

7093. On the radial pulsations of an infinite cylinder with a magnetic field parallel to its axis. E. LYTTKENS. *Astrophys. J.*, **119,** 413–24 (*March*, 1954).

Deals with the periods of the radial adiabatic pulsations of an infinitely conducting cylinder under its own gravity and a magnetic field parallel to its axis. For the case in which the magnetic field is a normal decay field in the cylinder, the characteristic values are tabulated. A.

525.34

7094. A singularity in the movement of the terrestrial poles occurring in 1926. A. DANJON AND B. GUINOT. *C.R. Acad. Sci.* [*Paris*] **238,** 1081–3 (*March* 8, 1954) *In French.*

From an analysis of the relevant data for the period, 1890–1953, it is shown that during 1926 the amplitude of the Chandlerian component (free nutation) of terrestrial polar perturbation changed sign in passing through zero value, resulting in a phase change of half-a-period for the polar co-ordinate fluctuation. The apparent period altered from 435 ± 2 days (1890–1924) to 428 ± 2 days (1929–53). The cause of this anomaly is not stated. D. R. BARBER

529.77

7095. The actual scientific possibility of time comparison at great distances. M. BOELLA. *Atti. Rass. tecn. Soc. Ingegn. Archit. Torino,* **6,** 249–50 [*Aug.–Sept.*, 1952] *In Italian.*

Results of experiments in 1951 show that short-wave transmissions between Washington and Turin take a time for transmission which is constant and calculable to within a tenth of a millisecond. In this paper the utility of this for the accurate determination of longitude and other scientific problems is discussed.

J. M. HOUGH

PHYSICS 53

53

7096. Dictionary of physics [Physikalisches Wörterbuch]. Two parts in one volume. Edited by W. H. WESTPHAL. *Berlin–Göttingen–Heidelberg: Springer-Verlag* [1952] vi + 833 and 795 *pp. In German.*

Reviews in *Naturwissenschaften*, **41**, No. 10, 239–40 (1954) *In German. Proc. Phys. Soc.* [*London*] *B*, **67**, 510–11 (*June*, 1954). "The material of this book, which is presented in the form of short articles, has been prepared by some eighty collaborators, many of whom are workers with international reputation. The pages are of large format, printed in double columns, the text contains 1595 figures, and the number of entries exceeds 10 000. The material is very up-to-date, and an emphasis seems to have been given to theoretical and mathematical physics."

53 : 548.73

7097. Some thoughts on the future of natural science, with illustrations from the growth of X-ray diffraction work in the United States. R. W. G. WYCKOFF. *Brit. J. appl. Phys.*, **5**, 199–204 (*June*, 1954).

The current replacement of private by governmental support has been giving more impetus to applied and systematic research than to that fundamental enquiry into nature which has been the traditional basis of modern science. Some aspects of the problem for the continued development of science that result from this are discussed against a background of X-ray diffraction in the United States. A.

53.081

7098. Hybrid concepts in physics. (A critique of concepts in electromagnetism.) R. FLEISCHMANN. *Naturwissenschaften*, **41**, *No.* 6, 131–5 (1954) *In German.*

Continuing a discussion of the distinction to be made between physical concepts and quantities [Abstr. 6720 (1951)] it is suggested that physical laws should be expressed in forms independent of the system of units employed. Such invariance will follow if systems involving hybrid concepts (e.g. a system in which "length" represents a measure of capacity as well as of displacement) are avoided.

R. A. NEWING

53.081

7099. Improved morphology of electromagnetics and the periodic system of physics. P. DE BELATINI. *Istanbul Tek. Üniv. Bült.*, **5**, 27–110 (1952).

In the first part of the paper, formal analogies between electric and magnetic concepts in electromagnetic theory are discussed. It is found necessary to replace considerations of duality by a scheme of triple symmetry, characterized by the three physical constants: permeability, dielectric constant, electric conductivity. Such a scheme would be analogous to the chemical periodic table, in that it would allow "missing" laws to be deduced from gaps in existing tabulated relations. In the second part, these considerations are extended to two other domains of physics: mechanics (including acoustics, hydrodynamics, gravitation) and thermal phenomena. The three "periodic systems" thus set up would have four basic units each, three of which are common to all (length, time, energy) and the fourth, "impedance," characteristic of the domain in question. G. FIELD

53.081.4

7100. Logarithmic measure and the decibel. W. M. HALL. Letter in *J. Acoust. Soc. Amer.*, **26**, 449–50 (*May*, 1954).

A simple method of expressing the logarithmic measure of physical quantities is proposed, which is generally applicable to all quantities and avoids the use and misuse of the term decibel. A.

53.088

7101. Organization of the neighbourhood G_ν of a quantity G with a view to a precise measurement. P. RENAUD, M. JOLY AND D. G. DERVICHIAN. *C.R. Acad. Sci.* [*Paris*] **238**, 1389–90 (*March* 29, 1954) *In French.*

It is impossible in the experimental determination of a quantity G not to obtain neighbouring values G_ν and in order to obtain G more precisely it is necessary to choose the G_ν so that they converge, as for example occurs if the difference $(G - G_\nu)$ is less than the tolerated error. It is shown that to satisfy the condition of convergence two sets of partial derivatives must vanish, the one corresponding to the system containing G and the other to the measuring instrument. S. WEINTROUB

FUNDAMENTALS 530.1

530.12

7102. On the 4 relations introduced in Einstein's gravitational theory. T. DE DONDER. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 12, 1024–6 (1953) *In French.*

The 10 equations should be modified on account of 4 supplementary relations introduced by the author in 1921. F. ANSBACHER

530.12

7103. On the connections between the principle of Maupertuis–Lagrange and that of Fermat on the one hand and the special theory of relativity and wave mechanics on the other. K. D. STIEGLER. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 12, 1052–63 (1953) *In French.*

It is shown that the fundamental laws of the special theory of relativity and of the wave mechanics of de Broglie can be deduced from the classical Fermat and Maupertuis–Lagrange principles with the aid of 9 axioms about the behaviour of particles and their associated waves, without presupposing the principle of the constancy of the velocity of light.

F. ANSBACHER

530.12

7104. On Kohler's formulation of the theory of gravitation. A. PAPAPETROU AND W. URICH. *Ann. Phys.* [*Leipzig*] **14**, *No.* 3–5, 220–32 (1954) *In German.*

A critical examination is made of theories in which the field is described in terms of two metric tensors

g_{ik} and $\bar{g}_{ik}$ [Abstr. 5845–6 (1953)], the general Lagrange density being taken as $\mathfrak{L}(\mathfrak{g}^{\alpha\beta}, \mathfrak{g}^{\alpha\beta}{}_{,\rho}; \{\overrightarrow{\rho\sigma, \kappa}\})$. Attention is drawn to difficulties arising from the fact that vacuum solutions are not uniquely determined by source distributions, and from the fact that the theory possesses too great a generality. The physical significance of the $\bar{g}_{ik}$ is discussed and it is suggested that the condition $\{\overrightarrow{\rho\sigma, \kappa}\} = 0$ might be regarded as an extension of the privileged inertial frames of special relativity. R. A. NEWING

530.12

7105. On the geodesics of the Einstein–Schrödinger universe. J. WINOGRADZKI. *C.R. Acad. Sci.* [*Paris*] **238,** 996–8 (*March* 1, 1954) *In French.*

The condition that the absolute derivative of the vector dx^l/ds shall vanish along a geodesic is found to be $g_{\underset{\sim}{\alpha l}}\Gamma^{\alpha}_{\underset{\sim}{km}} + g_{\underset{\sim}{\alpha k}}\Gamma^{\alpha}_{\underset{\sim}{lm}} = 0$. R. A. NEWING

530.12

7106. On the choice of the metric and of the electromagnetic field in Einstein's unified theory. S. MAVRIDÈS. *C.R. Acad. Sci.* [*Paris*] **238,** 1566–8 (*April* 12, 1954) *In French.*

Wyman [Abstr. 4072 (1951)] has shown that the metric tensor a_{ik} is not necessarily equal to the symmetric part of the tensor field g_{ik}. It is here shown that, by a suitable choice of a_{ik} and definition of the potentials, Papapetrou's exact solution of the field equations [Abstr. 4454 (1949)] can be made to give the static spherically symmetric field of Born–Infeld electrodynamics. R. A. NEWING

530.12 : 523.112

7107. Gravitation and universe. Foundations of theoretical cosmology. [Schwerkraft und Weltall. Grundlagen der theoretischen Kosmologie.] P. JORDAN. *Braunschweig: Vieweg & Sohn* (1952) viii + 207 *pp. In German.*

Review in *Z. angew. Math. Phys.*, **4,** *No.* 4, 323–5 (1953) In German. See also *Mathematical Reviews*, **14,** 1022 (*Nov.*, 1953). A concise exposition of Riemannian geometry and of Einstein's theory of gravitation is followed by an account of the author's extended (projective) theory of relativity in which the constant of gravitation becomes a field variable. The modified theory provides a basis for new cosmological models. A detailed account is given of Jordan's own cosmological theory.

530.12 : 523.877

7108. On a class of spherically symmetric solutions of Einstein's gravitational equations. O. KLEIN. *Ark. Fys.*, **7,** *Paper* 41, 487–96 (1954).

A solution is obtained based on the assumption that $p \propto (\varepsilon - \varepsilon_0)^{n+1}$ where $\varepsilon = 1/g_{44}$ and is shown to provide a relativistic analogue of the equilibrium of polytropic gas spheres. R. A. NEWING

530.145

7109. On a regular field theory. III. J. RAYSKI. *Acta phys. Polon.*, **13,** *No.* 2, 95–114 (1954).

For Pt II, see Abstr. 6267 (1954). A perturbation method applicable to local as well as to non-local field theories is presented and applied to the computation of the probability amplitude that a vacuum state remains a vacuum state. In order to secure convergence it is necessary to assume (besides the non-localizability of interaction) a finite space-time domain. It is shown also that in the non-local field theory the probability amplitudes are not expressible in terms of the causal functions of Stueckelberg and Feynman. A.

530.145

7110. Differential structure of non-local theories. I. J. RZEWUSKI. *Acta phys. Polon.*, **13,** *No.* 2, 135–44 (1954).

It is shown on an example of a one-dimensional linear integro-differential equation how to obtain a differential description of non-local systems. The equivalence of integro-differential and pure differential equations of the same order is proved under certain conditions about the kernel. The coefficients of the differential equation are discussed. The canonical quantization of the system is considered, and finally, another direct approach to the problem is given. A.

530.145

7111. On the equivalence of invariance under time reversal and under particle–antiparticle conjugation for relativistic field theories. G. LÜDERS. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **28,** *No.* 5, 17 *pp.* (1954).

For relativistic field theories, in a sense specified in the paper, the invariance under time reversal "of the second kind" (time reversal including particle–antiparticle conjugation) is proved mathematically. Consequently, the postulate of invariance under time reversal ("of the first kind") is, for field theories of this type, completely equivalent to the postulate of invariance under particle–antiparticle conjugation. A.

530.145

7112. New formulation of covariant field theory. R. CHENON. *C.R. Acad. Sci.* [*Paris*] **238,** 1382–4 (*March* 29, 1954) *In French.*

A treatment is indicated which avoids the initial introduction of space-like surfaces such as appear in the Schwinger–Tomonaga formalism. G. FIELD

530.145

7113. Quantization in spinor mechanics. A. PROCA. *C.R. Acad. Sci.* [*Paris*] **238,** 774–6 (*Feb.* 15, 1954) *In French.*

If the author's mechanics [Abstr. 5264 (1954)] is quantized by requiring that the spinors ξ, ξ^+ satisfy commutation relations, particles can have spin values 0, ½, 1, 3/2, 2 . . . and charges 0, ±1, ±2 . . . , but if ξ, ξ^+ satisfy anticommutation relations, the spins are restricted to 0, ½, 1 and the charges to 0, ±1, ±2. R. A. NEWING

530.145

7114. On the renormalization of the Salpeter-Bethe equation. A. CLAESSON. *Ark. Fys.*, **7,** *Paper* 46, 565–85 (1954).

In order to study the renormalization of the Salpeter–Bethe equation up to the fourth order in the coupling constant, the renormalization terms are introduced in the corresponding Lagrangian according to the methods given by Källén. Equations are obtained for the determination of the renormalization constants which are computed by power series expansion in the coupling constant. When these values are introduced into the Salpeter–Bethe equation, a finite result is obtained. A.

530.145

7115. Production of proton pairs. R. N. THORN. Letter in *Phys. Rev.*, **94,** 501 (*April* 15, 1954).

The cross-section for production is evaluated near threshold. For p–p collisions it is of the form $\sigma = 1{\cdot}4\times10^{-29}(f^2/4\pi)^4[(E-2M)/M]^{9/2}$ cm²; and for n–p collisions

$$\sigma = 5{\cdot}4\times10^{-29}(f^2/4\pi)^4[(E-2M)/M]^{7/2}\ \text{cm}^2.$$

In the calculations pseudoscalar mesons with pseudoscalar coupling are employed in intermediate states.

G. E. BROWN

530.145

7116. Production of antiprotons in p–p collisions. D. FOX. Letter in *Phys. Rev.*, **94,** 499 (*April* 15, 1954).

The cross-section is evaluated using the methods of Feynman. It is of the form:

$$\sigma = K(g^2/\pi)^4[(E-2M)/M]^{9/2}$$

near threshold, K being $1{\cdot}2\times10^{-25}$ cm² when production is brought about through the intermediary of pseudoscalar mesons with pseudovector coupling.

G. E. BROWN

530.145

7117. On certain solutions, with localized singularities, of the wave equations of particles in rectilinear and uniform motion. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **238,** 998–1001 (*March* 1, 1954) *In French.*

The form of such solutions is found for the Klein–Gordon and Dirac equations, in the absence of external fields, for the cases where the particle possesses spherical and prolate ellipsoidal symmetry in its own reference frame. G. FIELD

530.145

7118. On the solutions with localized singularities in the uniform rectilinear motion of particles of spin $\hbar$. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **238,** 1568–70 (*April* 12, 1954) *In French.*

An extension of the work of the preceding abstract.

P. T. MATTHEWS

530.145

7119. On unsolved problems in elementary particle theories. S. YIFTAH. *C.R. Acad. Sci.* [*Paris*] **238,** 1104–6 (*March* 8, 1954) *In French.*

The note summarizes the main properties of elementary particles which have yet to be explained, and discusses: mass spectrum, form of two-particle interactions, existence of anti-particles, stable charged states of different particles, the neutrino. G. FIELD

530.145

7120. Spinor rotations and reflections. I–II. H. J. GROENEWOLD. *Proc. K. Ned. Akad. Wetensch. B,* **56,** 169–78, 179–202 (*March–April,* 1953).

Spinor representations are considered of the groups of rotations (including Lorentz transformations) and reflections in ordinary 4-dimensional time-space as well as in a 6-dimensional space (with 1 redundant dimension) in which the former can aptly be embedded. In the 2-valued representations the reflections either all commute or partly anti-commute; only the latter lead to a proper representation. For various representations the reflection properties of some elementary tensors are collected in a table. A.

530.145

7121. The rank of the algebra of the matrices appearing in the method of fusion of Louis de Broglie. F. L. BAUER. *C.R. Acad. Sci.* [*Paris*] **238,** 1477–8 (*April* 5, 1954) *In French.*

A general formula is given for the rank of the algebra in the de Broglie theory of particles of arbitrary spin. P. T. MATTHEWS

530.145

7122. New proposal on the mass spectrum of elementary particles. S. YOSHIKAWA AND T. HASEBE. Letter in *Progr. theor. Phys.*, **10,** 359–61 (*Sept.*, 1953).

The formula $\mu = 137\times(1{\cdot}1959)^n m_e$ (where n = integral or half-integral) is proposed for the masses.

W. J. SWIATECKI

530.145

7123. The proton–neutron mass difference. R. P. FEYNMAN AND G. SPEISMAN. Letter in *Phys. Rev.*, **94,** 500 (*April* 15, 1954).

The proton is represented by the Dirac equation with an additional Pauli term to describe the anomalous moment; the neutron is treated similarly, but as a particle of charge zero. The coupling to the electromagnetic field can explain the mass difference if the anomalous moment term and the photon propagation function are cut off at appropriate momenta. G. E. BROWN

530.145 : 530.12

7124. A theory of the electron. H. T. FLINT AND E. M. WILLIAMSON. Letter in *Nuovo Cimento,* **11,** 568–9 (*May,* 1954).

In the 5-space field equations $P^{\mu\nu} - \frac{1}{2}\gamma^{\mu\nu}P = \chi T^{\mu\nu}$ [Abstr. 3093 (1954)], the constant χ is expressed as $-8\pi\kappa/c^4 + \delta e^2/2m_0^2c^4$ where $\delta = 1$ when charges are present and is zero otherwise. For an electron the scalar curvature in 4-space is found to be of the form $R = -(2/r^2)\exp(-4r/r_0)$. The significance of this result is discussed. R. A. NEWING

530.145

7125. A non-linear generalization of the Schrödinger and Dirac equations. M. SCHÖNBERG. *Nuovo Cimento,* **11,** 674–82 (*June,* 1954).

It is shown that it is possible to modify the Hamilton–Jacobi equation by the introduction of generalized potentials that lead to a modification of the total momentum, without introducing new forces. By means of the solutions of the modified Hamilton–Jacobi equations it is possible to describe the motions of more general classical ensembles of particles than those corresponding to the solutions of the ordinary Hamilton–Jacobi equation. The extension to quantum mechanics is straightforward and leads to a generalization of the Schrödinger equation by means of a system of non-linear equations. The same procedure leads to a generalization of the Dirac equation.

A.

530.145

7126. Further investigation on the S-matrix in meson theory. NING HU. *Acta Sci. Sinica,* **2,** 59–67 (*April,* 1953).

The path of integration for integrals involving the function $D'_F(k)$ defined in a previous paper [Ning Hu, *Chin. J. Phys.*, **8,** 40 (1951)] is specified in the present note. It was also pointed out that the effect of using $D'_F(k)$ is in certain respect equivalent to the introduction of a heavier quantum into the meson field. A.

530.145

7127. On the baryon-meson-photon system. A. PAIS. *Progr. theor. Phys.*, **10**, 457–69 (*Oct.*, 1953).

The considerations of the previous paper [Abstr. 2008 (1954)] of incorporating isotopic spin (ω-) space in the wave equation of heavy particles are extended here. In particular, the role of the V_1-particle in the scheme is discussed ("baryon" to denote p, n or V_1-particle). The concept of "ω-parity" and energy conservation are used to examine the possible identification of the V_1 with the $^2P_{3/2}$ baryon state. V_1 production in nucleon-nucleon and π-meson-nucleon collisions and single V_1-production from π-mesons (1000–1300 m_e) are discussed from this point of view. Formal aspects of the theory are sketched, in particular the baryon-meson-photon system is investigated and the Lorentz and gauge invariance of the Lagrangian. The problem of interpreting divergences is discussed.

G. FIELD

530.145

7128. Interaction of gravity with the particle vacuum. D. IVANENKO AND A. BRODSKIĬ. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 4, 731–4 (1954) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-218.

The Lagrangian, Green's function and energy are formed in the case of a scalar or pseudoscalar particle (meson) field; the results can be extended to fermions. The vacuum energy is evaluated to second order in the case of a weak gravitational field, and renormalization of length and mass is carried out.

G. E. BROWN

530.145

7129. On the theory of nucleon-nucleon scattering at high energies. K. FINCKE. *Ann. Phys.*[*Leipzig*] **14**, *No.* 3–5, 97–120 (1954) *In German.*

Three types of nuclear forces are investigated: (1) the hard core of Jastrow, (2) the spin-orbit coupling of Case and Pais, (3) a spin-spin interaction. Appropriate exchange characters for each potential are chosen. The effects of these potentials are calculated in Born approximation. None of these theories is able to explain the isotropy and constancy with energy of the p–p cross-section. Model (2) is found to be inadequate in other ways, and (1) and (3) about equally suitable.

G. E. BROWN

530.145

7130. Single-time formalisms from covariant equations. A. KLEIN. *Phys. Rev.*, **94**, 1052–6 (*May* 15, 1954).

The main purpose of this paper is to provide a concise general deduction of a result which has previously been reported and applied. The result is a single-time wave equation for a two-nucleon system obtained from the covariant two-body equation by means of an iteration procedure which employs the solution of the latter for an instantaneous interaction. The single-time wave function contains only positive energies. Possible generalizations to include negative-energy components and higher amplitudes are discussed, but none of these is carried out in detail. A.

530.145

7131. Effect of negative energy components in the two-nucleon system. R. ARNOWITT AND S. GASIOROWICZ. *Phys. Rev.*, **94**, 1057–62 (*May* 15, 1954).

A feature of the Lévy–Klein solution of the Bethe–Salpeter equation for the deuteron is the elimination of ϕ_{+-}, ϕ_{-+} and ϕ_{--} in terms of the ϕ_{++} component of the wave function via a perturbation expansion. To investigate the validity of this procedure, the coupled equations for the various components in the first nonadiabatic approximation to the Δ_+ interaction were examined. A set of first-order radial equations with multiplicative potentials (in the region $r > 1/m$) was obtained, involving $\phi_{\pm\pm}(r) = \frac{1}{4}(1 \pm \beta_1)(1 \pm \beta_2)\phi(r)$. A rigorous elimination of ϕ_{+-} and ϕ_{-+} led to equations containing ϕ_{++} and ϕ_{--}. By neglecting velocity-dependent terms, potentials of the type

$$\frac{\mu^2}{2m}\frac{g^2}{4\pi}\tau_1\cdot\tau_2\frac{Y(r)}{P_0+\frac{1}{2}(g^2/4\pi)\tau_1\cdot\tau_2 Y(r)}$$

appear. Expanding the denominator yields the usual Yukawa second-order potential plus a term proportional to $g^4(\tau_1\cdot\tau_2)^2$. Such an expansion, however, is poor even for $r \lesssim 1/\mu$, a pole actually existing near $r \sim 0{\cdot}7/\mu$ for the charge singlet state. (For $J = 1$, the structure of the lowest-order tensor interaction is greatly altered.) Thus, the perturbation expansion appears to radically alter the structure of the equations.

A.

530.145

7132. The unitarity of the U operator. H. EKSTEIN. *Phys. Rev.*, **94**, 1063–4 (*May* 15, 1954).

The U operator, which connects state vectors in interaction representation for different times, can be applied meaningfully to asymptotic values of state vectors $\Phi(\pm\infty)$ if these limits exist. The conditions for this occurrence are stated for the simplest case. If the restriction resulting from the definition of the asymptotic values is respected, all U operators are unambiguously unitary. A more general operator W which can act on all state vectors, can be defined, but it is not unitary.

A.

530.145

7133. An operator useful in the Bhabha equation. F. E. PRIETO C. *Rev. Mexicana Fis.*, **3**, 24–42 (*Jan.*, 1954) *In Spanish.*

An explicit form of the operator $p^2(p-\kappa)(p^2-a_j^2m_i^2)$, needed in the calculation of matrix elements for any process, and whose columns are free particle solutions of the equation $(p+\kappa)\psi = 0$, is given in this paper for the case of the Bhabha equation [Abstr. 1445 (1952)].

A.

530.145

7134. The algorithm of the Dirac function. Elementary justification and application to classical equations. L. CASTOLDI. *R.C. Accad. Naz. Lincei*, **16**, 18–25 (*Jan.*, 1954) *In Italian.*

A variation of the Dirac δ-function is used in the integral representation of a function and its derivatives. Extension is made to the case of several dimensions and application is made to the Laplace equation and the wave equation. For the latter the Kirchhoff formula is established.

L. S. GODDARD

530.145

7135. Perturbation theory for the one-dimensional [Schrödinger] wave equation. P. J. PRICE. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 383–5 (*April*, 1954).

A method is described which gives the ground-state solution of the eigenvalue problem, to any required

order, in terms of the unperturbed wavefunction only. G. FIELD

530.145

7136. Single-time methods in field theory. W. ZIMMERMANN. Letter in *Nuovo Cimento*, **11**, 559–61 (*May*, 1954) *In German.*

A brief discussion of various recently proposed generalizations of the "wave function" in field theory. P. T. MATTHEWS

530.145

7137. Yang–Feldman formalism and single-time wavefunctions. W. ZIMMERMANN. *Nuovo Cimento*, **11**, 577–89 (*June*, 1954) *In German.*

The integral equations of the new Tamm–Dancoff method [Abstr. 97 (1954)] are derived with the aid of the Yang–Feldman formalism. The inhomogeneous terms of these equations contain the boundary conditions at the time $t = \pm \infty$. A.

530.145 : 532.5

7138. On a two-fluid model of matter. F. A. KAEMPFFER. *Canad. J. Phys.*, **32**, 430–4 (*June*, 1954).

The theory of Pauli and Weisskopf is reformulated in hydrodynamical terms by introduction of a suitable density ρ and a suitable velocity potential ϕ. The Hamiltonian of the system is expressed in terms of ρ, ϕ and their canonical momenta. In accordance with a general programme proposed by the author the transition to quantum theory is carried out along the lines of quantum hydrodynamics. The eigenvalues of the Hamiltonian corresponding to excitations of the motion with no net mass flow are obtained. Since these excitations do not give rise to an electromagnetic field, they are tentatively identified with neutrino-like particles. The picture emerging from these considerations is that of two interpenetrating fluids of positive and negative charge, in which different types of elementary particles appear as different types of excitations of the motion. A.

530.145 : 536.7

7139. Thermodynamic foundation of quantum mechanics. A. LANDÉ. *Naturwissenschaften*, **41**, *No.* 6, 125–31 (1954) *In German.*

The laws of quantum mechanics are derived from Leibniz's principle of the continuity of cause and effect. The requirement of continuity of entropy change in the diffusion of two gases (as a function of the states of the gases) leads to the existence of quantum probabilities and, with further plausible assumptions, of probability amplitudes obeying a superposition principle. Quantum dynamics follows from a suitable definition of canonical conjugate quantities, while quantum statistics can be derived from a "principle of continuity of symmetry character." E. H. SONDHEIMER

530.162

7140. The connection between the Smoluchowski equation and the Kramers–Chandrasekhar equation. R. W. DAVIES. *Phys. Rev.*, **93**, 1169–70 (*March* 15, 1954).

It is shown that the Kramers and Chandrasekhar extension of the Fokker–Planck equation to phase space leads to a modified Telegraph or hyperbolic-type diffusion equation in configuration space. The solution of this equation at large times asymptotically approaches the solution of the Smoluchowski equation. The hyperbolic diffusion equation and the Smoluchowski equation differ by one term which is related to the fact that particle velocities exist in the former case whereas in the latter case they do not. A.

530.162

7141. Errors in power spectra due to finite sample. L. M. SPETNER. *J. appl. Phys.*, **25**, 653–9 (*May*, 1954).

An estimate is made of the accuracy with which the "spectrum" of a finite sample of Gaussian noise approximates the spectrum of the original noise from which the sample was taken. The sample is considered to be spliced to form an endless loop, thereby making it a periodic function. The effect of this splice is also discussed. A.

530.162 : 621.391

7142. Negentropy and information in telecommunications, writing, and reading. L. BRILLOUIN. *J. appl. Phys.*, **25**, 595–9 (*May*, 1954).

The negentropy principle of information discussed in a previous paper [Abstr. 100 (1954)] is applied to the technical problems of telecommunication. Using a thermodynamical discussion one obtains the Shannon formula for the capacity of a channel with noise. This example proves again the connection between information and negentropy. The problem of writing and reading is examined. It is a type of "dead information" which must be re-energized for reading: The source of light needed for reading provides the negentropy which is changed into information by the reader. The negentropy connected with "organization" is also discussed. All these examples show the connection between information and negentropy. They are of great importance for a theory of information, although the entropy amounts involved may be completely negligible. A.

530.162 : 621.391

7143. Information theory and knowledge. D. K. C. MACDONALD. *J. appl. Phys.*, **25**, 619–22 (*May*, 1954).

Distinction between data transmission from one person (or point) to another and the inception of new knowledge is analysed in relation to information theory. The customary measure $H = -\Sigma_i p_i \log p_i$ applies essentially to the former case, and after discussing the requirements appropriate to a yardstick for new knowledge an elementary measure for this concept is tentatively proposed. The intuitive requirements, however, are not all mutually compatible and the present measure can only be regarded as provisional; in particular some "memory" characteristics appear mandatory for future development. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.224.7

7144. Application of the method of electrical networks to calculation of the deformation of elastic plates. J. BOSCHER. *C.R. Acad. Sci.* [*Paris*] **238**, 1189–92 (*March* 15, 1954) *In French.*

The method described in Abstr. 6312 (1954) is

applied to a study of the deformation of plates under different boundary conditions. The results for a square plate supported at each edge or at 3 edges only are given and show good agreement with theory.

H. J. H. STARKS

MECHANICAL MEASUREMENTS 531.7

531.711.1 : 535.417

7145. Method for comparing a line standard and a wavelength of light. J. TERRIEN. *C.R. Acad. Sci. [Paris]* **238,** 1001–3 (*March* 1, 1954) *In French.*

A discussion is given of a method of using glass plates with a Michelson interferometer so adapted that a line-standard can be converted optically into an end-standard. The method involves the introduction of silvered plates into the path, the plates having lines scratched into the silver and by an interchanging method the line-standard is converted to an optical end-standard. S. TOLANSKY

531.715

7146. A new method for the measurement of small changes in length. D. KUHLMANN-WILSDORF. *Z. angew. Phys.*, **6,** *No.* 4, 171–4 (1954) *In German.*

The instrument described consists of a horizontal roller which is divided into two parts of different radii and which is supported by two vertical bands. The upper band is fastened at one end to the part of smaller radius and the lower band to the other part. The other ends of the bands are fastened to the two points between which the changes in length are to be measured. The rotation of the roller is measured by means of a mirror attached to the roller. Details of suitable properties and materials for the bands, the types of measurement and of the practical application, range of use and sensitivity of the instrument are given. S. WEINTROUB

531.717 : 539.23 : 538.221

Thickness of films by magnetic method. *See Abstr.* 7559

531.717.7

7147. Variants of a new spherometer method. B. JUREK. Letter in *Czech. J. Phys.*, **4,** 97 (*Feb.*, 1954) *In German.*

Two alternative layouts of a double prism attachment, allowing the accurate measurement of radii of curvature by auto-collimation, are described.

R. W. FISH

531.717.8

7148. On the examination of nearly straight edges (rulers) and of nearly plane surfaces. R. E. H. RASMUSSEN. *Fysisk T.*, **51,** *No.* 5–6, 129–43 (1953) *In Danish.*

Formulae are derived for deducing the deviations from a straight line (plane) of an approximately straight edge (approx. plane surface) from measurements of gaps between 3 edges (surfaces) taken 2 at a time. Formulae for the standard deviation in the final results arising from errors in the individual gap measurements are given. Illustration by means of an example in which interference fringes were used to measure the gaps. W. J. SWIATECKI

531.756 : 536.414

7149. Determination of the density of melts, and classification of solids into "space-weak" and "space-strong" at high temperatures. A. KNAPPWOST AND H. RESTLE. *Z. Elektrochem.*, **58,** *No.* 2, 112–18 (1954) *In German.*

Describes a new method for determining the density of metal melts, enabling the density to be determined of substances the melting-point of which lies in temperature ranges where buoyancy methods can hardly be used. The melt heated to a high temperature is poured through a channel into a hollow mould which is completely filled and then closed by means of a simple valve. The volume of a wax model of the cavity is determined exactly by the buoyancy method and the model is then embedded into a ceramic mass and burnt out after the mass has been hardened. It is shown for Si that the new method makes it possible to estimate the sign of the volume change at the melting-point, when the thermal stability of the ceramic mass is insufficient for conducting an accurate determination of density. F. LACHMAN

531.787.2

7150. Pressure gauge for the cm range. J. B. JOHNSON AND N. T. WILLIAMS. *Rev. sci. Instrum.*, **25,** 393 (*April*, 1954).

A flexible diaphragm in a metal housing is replaced by a metal bellows in a glass tube, resulting in simpler operating technique. The sensitivity of the gauge depends on the structure of the bellows.

G. WITTENBERG

531.787.6

7151. A sensitive air manometer. L. F. G. SIMMONS. *J. sci. Instrum.*, **31,** 195–7 (*June*, 1954).

Two air columns maintained at different temperatures constitute the limbs of a manometer which is suitable for measuring very small differences of air pressure. In use the effective height of the columns is adjusted until the air in the manometer comes to rest, which is indicated by the aid of smoke; the applied differential pressure is then calculated from the known temperature difference on the two sides of the manometer. The upper limit of the instrument is about $14 \cdot 5$ dyn/cm^2, or $0 \cdot 15$ mm head of water; the sensitivity is of the order $0 \cdot 00516$ dyn/cm^2, that is, equivalent to a pressure head of $5 \cdot 16 \times 10^{-5}$ mm of water. A.

531.787.6

7152. An apparatus for measuring small changes in liquid level. E. KOVAČIČ. *J. sci. Instrum.*, **31,** 205–6 (*June*, 1954).

An instrument is described which, by using a sensitive spirit level mounted upon a float, indicates level differences or differential air pressures down to 1 μ of water. Changes in the draught of the float that could be introduced by the displacement of air bubble are precluded by means of spherical supports. A.

MECHANICS OF FLUIDS 532

532.13 : 530.162 : 536.22

7153. Statistical mechanical theory of transport processes. VII. The coefficient of thermal conductivity of monatomic liquids. R. W. Zwanzig, J. G. Kirkwood, I. Oppenheim and B. J. Alder. *J. chem. Phys.*, **22**, 783–90 (*May*, 1954).

For Pt VI, see Abstr. 2064 (1954). A molecular theory of the coefficient of thermal conductivity is developed from the general theory of transport processes presented in Pt I. The thermal conductivity of liquid argon at its normal boiling point is evaluated using the Lennard-Jones intermolecular potential and a theoretically determined radial distribution function. The theory leads to an explicit expression for the product of the thermal conductivity and the friction constant of the theory of Brownian motion. With a reasonable estimate of the friction constant, the results of the theory agree satisfactorily with experiment. A.

532.137 : 532.61

7154. Viscometry—The meniscus resistance in capillary flow of liquids. G. F. N. Calderwood and E. W. J. Mardles. *Proc. Phys. Soc.* [*London*] *B*, **67**, 395–400 (*May*, 1954).

Experiments first described by Barr [Abstr. 2786 (1946)] on surface tension effects in viscometry, relating to the influence of a wetting agent on flow times in standard viscometers, have been continued. A disturbing surface tension effect has been traced to meniscus resistance, particularly of the recessional meniscus, the resistance being decreased by wetting agents and increased with increase of contact angle. With a variety of oils of different chemical composition and of different surface characteristics, the reproducibility of viscosity results obtained with standard viscometers and by the procedure laid down in the latest I.P.–A.S.T.M. method varied up to 0·5%, a coefficient of error greater than that usually obtained with mineral oils alone. A.

532.5 : 538.69

7155. Magneto-hydrodynamic waves in liquid sodium. B. Lehnert. *Phys. Rev.*, **94**, 815–24 (*May* 15, 1954).

Liquid sodium, because of its higher electrical conductivity and lower density, is more suitable than mercury for magneto-hydrodynamic experiments. Torsional waves in liquid sodium have been generated in a cylindrical vessel with the axis parallel to a homogeneous magnetic field, and resonance phenomena have been investigated at constant frequency and variable magnetic field strength. The agreement between theory and experiment is satisfactory. It is shown that even with sodium, damping plays an important role under laboratory conditions. The calculations are also used to improve the results of earlier investigations with mercury. A.

532.511

7156. Characteristic surfaces of the equations of motion for non-Newtonian fluids. J. L. Ericksen. *Z. angew. Math. Phys.*, **4**, *No.* 4, 260–7 (1953).

From the differential equations for the velocity components in steady flow of a certain general type of non-Newtonian fluid, a condition is derived for characteristic directions. In the plane of a two-dimensional flow there are in general six such directions, and these are determined. J. G. OLDROYD

532.525

7157. Some phenomena associated with supersonic liquid jets. B. Dunne and B. Cassen. *J. appl. Phys.*, **25**, 569–72 (*May*, 1954).

Supersonic liquid jets were produced in air by means of a spring-loaded injector. At high jet velocities another type of breakup seems to occur besides the classical Rayleigh surface tension breakup, and the sinuous aerodynamic breakup. Rotationally symmetric waves are formed, and appear to "break" analogous to wind-produced waves on a body of water. The rate of cavitation of jets in water was studied for several jet velocities above the speed of sound in air. A.

532.528 : 534.322.3

Ultrasonic spectrum of cavitation noise in water. *See Abstr.* 7221

532.582.5

7158. Limiting pressure on hydrofoils at small submergence depths. E. V. Laitone. *J. appl. Phys.*, **25**, 623–6 (*May*, 1954).

It is shown that the magnitude of the local velocity and the surface pressure coefficient can be limited over the entire upper surface of a two-dimensional hydrofoil as it approaches the free water surface. In this limiting condition the flow over the upper surface is governed by the shallow water wave propagation phenomenon, and the limiting pressure or velocity is determined by the maximum depth attainable from the hydraulic jump relations. The experimental data verifies this new theory and proves that the previous two-dimensional hydrofoil theories are valid only for relatively deeply submerged bodies. A.

532.59

7159. On a pressure wave in liquids. A. Carrelli and G. Branca. *Nuovo Cimento*, **11**, 590–5 (*June*, 1954) *In Italian.*

If a liquid in which a system of stationary ultrasonic waves is crossed by a beam of light in the direction normal to the one along which there is a variation of pressure and therefore of refractive index, one observes, at a certain distance, a number of clear and dark lines. Superposing now on this variation of pressure another variation due to any other cause, and having the same direction as the first one, the lines are displaced parallel to themselves. Taking a sequence of pictures on a film, one can measure the displacement of any line (either a luminous or a dark one). If the direction of propagation of ultrasonics and the direction of the pressure wave are perpendicular to each other, and both perpendicular to the direction of light, there is no displacement of the lines. A pressure wave in a liquid can thus be detected by this optical method. A.

532.595

7160. On the velocity of propagation of pressure waves in an incompressible viscous fluid enclosed in a tube with an elastomeric wall. G. Karreman. *Bull. math. Biophys.*, **16**, 103–9 (*March*, 1954).

Rashevsky's treatment of the flow of an incompressible viscous fluid in an elastic distensible tube is

applied to the same problem, except that the wall of the tube is assumed to be elastomeric. As a result the velocity of propagation is obtained in terms of the elastomeric constants of the wall, the thickness and density of the wall, the viscosity of the fluid, and the radius of the tube. A.

CAPILLARITY 532.6

532.61.08

7161. Surface tension at elevated temperatures. I. Furnace and method for use of the sessile drop method; surface tension of silicon, iron and nickel. W. D. Kingery and M. Humenik, Jr. *J. phys. Chem.*, **57**, 359–63 (*March*, 1953).

Difficulties in the experimental determination of surface tension at elevated temperatures have been overcome by use of the sessile drop method with precise methods of measurement. A description of the sessile drop method of surface tension determination is included with a description of an induction furnace suitable for determining the shape of sessile drops *in vacuo* or in pure atmospheres up to temperatures of at least 2000°. Methods of obtaining precise measurements capable of yielding surface tensions within ± 2–3% are described. Calculations of the surface tension of water and molten silver by the sessile drop method gave values in good agreement with determinations by other methods. Surface tensions of liquid silicon, iron and nickel have been measured. A.

532.612

7162. On the relation between the surface tension of certain solutions and the time of formation of the surface. M. Quintin and P. Biro. *C.R. Acad. Sci. [Paris]* **238**, 1016–18 (*March* 1, 1954) *In French.*

The authors apply their method [Abstr. 4232 (1954)] to a number of solutions. By plotting $\ln(\gamma_d - \gamma_s)$ against time of drop formation (γ_d = dynamic surface tension, γ_s = static surface tension) a straight line is obtained which permits very accurate extrapolation of surface tension values. A number of different solutions appear to have the same value of γ_d.

T. C. TOYE

532.614.2 : 548.7

The surface energy of colloidal metals in ionic lattices. *See Abstr.* 7864

532.64

7163. Surface roughness as related to hysteresis of contact angles. I. The system paraffin–water–air. F. E. Bartell and J. W. Shepard. *J. phys. Chem.*, **57**, 211–15 (*Feb.*, 1953).

Surface roughness has been defined in terms of the average height of the asperities, h; and the average angle of inclination of the faces of the asperities to the horizontal, ϕ. A quantitatively reproducible roughness was produced on paraffin wax surfaces and the apparent angles of contact made by water drops on these surfaces were measured. Conditions for the formation of reproducible contact angles on roughened surfaces have been stipulated. The advancing contact angle was found to increase with an increase in the angle of inclination, ϕ, while only a slight decrease, if any, was observed in the receding contact angle. Hysteresis was found to increase with an increase in the angle of inclination, ϕ, but to be relatively independent of the height, h. On the basis of the results obtained a mechanism for the advancement of water drops across roughened paraffin wax surfaces is proposed. A.

532.64

7164. Surface roughness as related to hysteresis of contact angles. II. The systems paraffin–3 molar calcium chloride solution–air and paraffin–glycerol–air. F. E. Bartell and J. W. Shepard. *J. phys. Chem.*, **57**, 455–8 (*April*, 1953).

Paraffin wax surfaces of controlled roughness were prepared (preceding abstract) by ruling in such a manner as to produce on the surface regular pyramids of height h and angle of inclination ϕ of the faces. As with the system paraffin wax–water–air already reported upon, so also in the systems paraffin wax–3 M calcium chloride–air and paraffin wax–glycerol–air, contact angle values were unaffected by changes in the height h. For the system paraffin wax–3 M calcium chloride–air, both the apparent advancing and the apparent receding contact angle values increased for an increase in ϕ. For the system paraffin wax–glycerol–air, the apparent advancing contact angle values increased, while the apparent receding contact angle values decreased for an increase in ϕ. Hysteresis values for both systems studied increased with an increase in the angle of inclination, but were relatively independent of changes in the height of the asperities. Wenzel's theory was found to be inapplicable to the data obtained for the paraffin wax systems involving water, 3 M calcium chloride, and glycerol. It was demonstrated that the contact angle and resultant drop shape are determined at the line of contact of the solid– iquid–air interface and are not altered by surface irregularities beneath the bulk of the drop. A.

532.64

7165. Surface roughness as related to hysteresis of contact angles. III. The systems paraffin–ethylene glycol–air, paraffin–methyl cellosolve–air and paraffin–methanol–air. J. W. Shepard and F. E. Bartell. *J. phys. Chem.*, **57**, 458–63 (*April*, 1953).

Paraffin wax surfaces of controlled roughness were prepared as previously described. These surfaces were used to study the effect of roughness on contact angles formed by liquids which on a smooth paraffin wax surface formed contact angles less than 90°. For ethylene glycol and for methyl cellosolve on these roughened paraffin wax surfaces, as the angle of inclination ϕ of the pyramid faces increased, the apparent advancing contact angle values increased, while the apparent receding contact angle values decreased. For methanol on these surfaces, as the angle ϕ increased, the apparent advancing contact angle decreased while the apparent receding contact angle became zero. The hysteresis observed increased with an increase in ϕ except for methanol for which the hysteresis observed decreased. Changes in the height h had no effect on the observed contact angles nor on hysteresis. Wenzel's theory was found inapplicable to these systems. On the basis of these and previous results an explanation of the effect of surface roughness is proposed. A.

532.64 : 536.7

7166. A thermodynamic derivation of Wenzel's modification of Young's equation for contact angles; together with a theory of hysteresis. R. J. Good. *J. Amer. Chem. Soc.*, **74**, 5041–2 (*Oct.* 20, 1952).

Wenzel's modification [*J. Phys. Coll. Chem.*, **53**, 1466 (1949)] of Young's equation for contact angles may be derived from considerations of free surface energy, though not from the assumption that surface "tensions" may be represented by vectors. A theory is presented for the hysteresis of contact angles. The "driving force" toward the attainment of an equilibrium contact angle is found to be equal to the surface tension of the liquid times the deviation of the cosine of the contact angle from its equilibrium value. It is shown that this may be equated to the "contortional energy" F_c that the drop must have in order for its edge to surmount a ridge. The result is in the same form as the equation of Adam and Jessop: $r(\gamma_1 - \gamma_2) = \gamma_2 \cos\theta_{a,r} \pm F_c$, but with a new and physically meaningful interpretation of F_c. A.

532.65 : 536.423

Studies of evaporation of small drops. *See Abstr.* 7358

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

7167. Theory of the migration processes in liquids. K. Wirtz. *Z. Elektrochem.*, **58**, *No.* 2, 109–12 (1954) *In German.*

The change of place in relation to the adjacent particles, and the viscosity phenomena in the more remote environment contribute to the velocity of migration of particles of molecular size in liquids (diffusion, ionic mobility, etc.). An attempt is made at analysing these contributions, and some migration laws (Stokes's, Ricke's) for molecules are discussed. It is found that the validity of these approximations can be only expected for the boundary cases.

F. LACHMAN

532.7

7168. Critical study of Falkenhagen and Kelbg's method for derivation of statistics for particles of finite size. M. Dutta. *Ann. Phys.* [*Leipzig*] **14**, *No.* 3–5, 188–92 (1954).

Falkenhagen and Kelbg [Abstr. 2244 (1953)] have used the author's formula for the distribution of ions in solution as a basis for a general statistics for particles of finite size. This theory is here critically reviewed and a number of assumptions questioned. See also Abstr. 3967 (1952). T. C. TOYE

532.7 : 532.13

7169. Structure of the liquid state and viscosity of hydrocarbons. R. J. Moore, P. Gibbs and H. Eyring. *J. phys. Chem.*, **57**, 172–8 (*Feb.*, 1953).

Viscosities of anisometric molecules are considered in terms of possible liquid structures derived from molecular volumes and other physical properties. Observed discontinuities in the several properties with temperature are interpreted as changes in molecular packing in the liquid due to onset of specific molecular motions. At least three liquid "regions" are postulated: (1) at low temperatures the molecular motion is largely translational, (2) at intermediate temperatures rocking or "libration" is an added factor, and (3) at higher temperatures, free rotation of the molecules on their long axes takes place. Flow of liquids in these regions is a co-operative phenomenon with low heats and negative entropies of activation for flow. In the case of molecules whose irregular configuration precludes formation of the required regular lattice, flow is by "jumping" of individuals with consequent high heats and positive entropies of activation for flow. A.

532.7 : 533.7

7170. The statistics of ideal mixtures taking into account the space requirement of the particles. R. Schlögl. *Z. phys. Chem.*, **202**, 379–89 (*Jan.*, 1954) *In German.*

A statistical derivation is given of the function used by Freise [see *Z. Electrochem.*, **56**, 822 (1952); also Abstr. 3967 (1952), 6286 (1953)] for the distribution of ions in the diffuse double layer. The function is shown to lead to a thermodynamically consistent description of equilibrium. The appropriate distribution functions for sedimentation equilibria in vacuum and in liquids are adduced.

W. GOOD

532.72

7171. Self-diffusion and structure of liquid water. III. Measurement of the self-diffusion of liquid water with H^2, H^3 and O^{18} as tracers. J. H. Wang, C. V. Robinson and I. S. Edelman. *J. Amer. Chem. Soc.*, **75**, 466–70 (*Jan.* 20, 1953).

For Pt II, see Abstr. 105 (1952). Measurements of the diffusion of small amounts of deuterium hydroxide and tritium hydroxide in ordinary water were made at several temperatures. Previous data on the diffusion of $H_2^1O^{18}$ in ordinary water have been revised. The results confirm previous conclusions regarding the structure of water and the mechanism of self-diffusion, dipole orientation and viscous flow in water. The effect of the differences in the moments of inertia of various water molecules is discussed. A.

532.72

7172. Diffusion in a central field due to van der Waals attraction. R. S. Bradley. *J. phys. Chem.*, **57**, 307–9 (*March*, 1953).

The influence of intermolecular attraction on the rate of diffusion has been studied for the evaporation of a drop at the centre of a spherical enclosure and for diffusion of solute molecules up to another solute molecule. For the first example the effect is very small and no correction is necessary for diffusion coefficients deduced from observations on evaporating drops. For diffusion in solution the rate for a typical example may be increased by 28%. A.

532.72

7173. A micro-method for the measurement of self-diffusion coefficients of solutions. J. Rolfe. *Proc. Phys. Soc.* [*London*] *B*, **67**, 401–8 (*May*, 1954).

A modification of the micro-diffusion method of Fürth and Zuber for measuring the diffusion of a β-active electrolytic solution into a non-radioactive but otherwise identical solution is described. The

apparatus can be used to determine self-diffusion coefficients of ions and their dependence on concentration. Results on sodium iodide, using iodine 131, and orthophosphoric acid, using phosphorus 32, are given and discussed on the basis of existing theories. Further applications of the method are suggested. A.

532.72 : 535.417

7174. Estimation of heterogeneity from diffusion measurements. P. A. CHARLWOOD. *J. phys. Chem.*, **57**, 125–8 (*Jan.*, 1953).

An expression has been derived for the standard deviation of the distribution of diffusion constants of a mixture. It requires the calculation of the fourth moments of refractive index gradient curves, or equivalent calculations from interference patterns. A procedure has been worked out for using interference patterns. An empirical curve-fitting method is of great use in some cases in obtaining corrected values of $D_{2,0}$ and $D_{4,2}/D_{2,0}$. Both experimental and theoretical patterns confirm that the use of moments higher than the second is impracticable in cases where the degree of heterogeneity is low. Efforts should, therefore, be made to attain a high degree of accuracy in the measurement of D_A and $D_{2,0}$ for proteins. A.

532.72 : 535.417

7175. Estimation of heterogeneity from diffusion measurements. G. HERDAN. Letter in *Nature* [*London*] **172**, 581–2 (*Sept.* 26, 1953).

Charlwood (see preceding abstract) showed that a measure of the heterogeneity of molecular weights of proteins could be obtained from an estimate of the standard deviation (σ) of diffusion constants but that the estimate of σ was likely to be unreliable under certain conditions. The present author shows that a reliable quantitative estimate can be made under these particular conditions by using an alternative statistical equation from that used by Charlwood. J. IBALL

532.72 : 535.42

A general theory for the Gouy diffusion method. *See Abstr.* 7339

532.77

7176. Excess heats and volumes of mixing. P. MEARES. Letter in *J. chem. Phys.*, **22**, 955–6 (*May*, 1954).

Supplementing a paper by Thacker and Rowlinson [Abstr. 4246 (1954)], the values for a number of liquid mixtures are discussed which support the views held in the paper mentioned. Simple theoretical calculations are shown to agree closely with experiment. T. C. TOYE

MECHANICS OF GASES 533

533.5 : 531.788

7177. On pressure measurement with the Pirani gauge. K.-D. MIELENZ. *Z. angew. Phys.*, **6**, *No.* 3, 101–4 (1954) *In German.*

A standard form and arrangement of gauge is described. The filament consists of 1 metre of 20 μ Pt wire. An expression for the sensitivity is derived and it is shown that by proper choice of arrangement and particularly the wall and filament temperatures maximum sensitivity can be obtained. This has been verified experimentally and a gauge constructed, for which experimental values are tabulated and shown graphically, which will measure pressures down to $1{\cdot}7\times10^{-5}$ mm Hg. S. WEINTROUB

533.5 : 771.53

Evacuating photographic materials for use in electron optical apparatus. *See Abstr.* 7963

533.56

7178. Glass–mercury diffusion pump which can be taken apart. G. C. MÖNCH. *Z. angew. Phys.*, **6**, *No.* 2, 59–61 (1954) *In German.*

Comparison of a glass mercury pump, having a removable jet, with commercially available pumps. At pressures near 10^{-1} mm Hg, the speed of the new pump is considerably greater than that of conventional types. G. WITTENBERG

533.56

7179. Investigations on glass–mercury diffusion pumps. I. M. REICHARDT. *Z. angew. Phys.*, **6**, *No.* 2, 61–4 (1954) *In German.*

The influence on pumping speed and throughput of variations in heat input, jet size, bore of mercury tube and cooling water temperature was investigated for a pump of 20 mm diameter. G. WITTENBERG

533.56

7180. Investigations on glass–mercury diffusion pumps. II. M. REICHARDT. *Z. angew. Phys.*, **6**, *No.* 3, 105–8 (1954) *In German.*

Further investigations on the effect of various design features on the pumping speed and throughput of a 20 mm dia. pump. The results are applied to single-stage and three-stage systems. G. WITTENBERG

533.58

7181. Ionic pump. A. M. GUREWITSCH AND F. WESTENDORP. *Rev. sci. Instrum.*, **25**, 389 (*April*, 1954).

A pump of simple construction and small size for the absorption of gases is described. Its operation depends on the production of ions by electrons oscillating in a combined electric and magnetic field. The pump can be used at pressures varying from $0{\cdot}1$ mm Hg to 5×10^{-7} mm Hg. Gas volumes of 27 cm^3 N_2 and 70 cm^3 air (s.t.p.), for example, can be absorbed without saturation effects. An example of the pumping speed is given. G. WITTENBERG

533.6.011.3 : 534.21

An acoustic streaming experiment in gases. *See Abstr.* 7188

MOLECULAR THEORY OF GASES 533.7

533.7 : 536.71

7182. Second virial coefficients of He^3 and He^4. J. E. KILPATRICK, W. E. KELLER, E. F. HAMMEL AND N. METROPOLIS. *Phys. Rev.*, **94**, 1103–10 (*June* 1, 1954).

The second virial coefficients of He^3 and He^4 have been calculated at closely spaced temperatures over the range $0{\cdot}3$°K to 60°K using the Lennard–Jones

12–6 potential with constants determined by de Boer and Michels. The necessary phase shifts were calculated on a high-speed electronic digital computer. The resulting He^4 second virial coefficients agree very well with the available experimental data. They also join nicely at 60°K with the coefficients calculated from the high-temperature classical equation with quantum corrections. The second cross virial coefficients for He^3, He^4 have also been calculated. The deviation of a gaseous solution of He^3 and He^4 from an ideal solution is comparatively small at temperatures above about 2°K, while at very low temperatures pronounced quantum solution imperfection appears. A.

533.7 : 539.13

The intermolecular potentials for some simple non-polar molecules. *See Abstr.* 7606

VIBRATIONS . ACOUSTICS 534

534.015.1

7183. On the forced oscillations of non-linear systems with two degrees of freedom. D. Graffi. *R.C. Accad. Naz. Lincei*, **16**, 176–80 (*Feb.*, 1954) *In Italian.*

Various properties are studied of the periodic solutions, with period $2\pi/\omega$, of the system (g_1 and g_2 being arbitrary functions): $L_1\ddot{x}_1 + M\ddot{x}_2 + g_1(\dot{x}_1) + K_1x_1 = e_1\cos(\omega t + \gamma_1)$ $M\ddot{x}_1 + L_2\ddot{x}_2 + g_2(\dot{x}_2) + K_2x_2 = e_2\cos(\omega t + \gamma_2)$. In particular, upper limits are given for the root mean square values and the absolute values of $\dot{x}_1$ and x_2. L. PINCHERLE

534.1

7184. Mechanical vibration. G. W. Van Santen. *Eindhoven: Philip's Technical Library; Houston: Elsevier Press* (1953) 296 + xvi *pp.*

Review in *Rev. sci. Instrum.*, **25**, 381 (*April*, 1954).

534.112

7185. Transverse oscillations in travelling strings. R. A. Sack. *Brit. J. appl. Phys.*, **5**, 224–6 (*June*, 1954).

The behaviour of transverse standing waves is examined for a uniform string which is pulled over two smooth supports under constant speed and tension. A harmonic spectrum of resonance frequencies is found which, for small ratios of the speed of travel to the propagation velocity of transverse waves, are only slightly lower than those of a string with clamped ends. The frequency response to a simple harmonic disturbance and the envelope of the oscillations are similar to those of a clamped string, but the phase of oscillation varies from point to point so that the instantaneous configuration of the string is not a sine curve. The conclusions remain valid in the presence of damping. A.

534.121

7186. Axially symmetric vibrations of a finite isotropic disk. IV. R. R. Aggarwal and E. A. G. Shaw. *J. Acoust. Soc. Amer.*, **26**, 341–2 (*May*, 1954).

For Pt III, see Abstr. 5337 (1953). The method described in Pt III has been applied to another normal mode of a particular disk by combining the motions corresponding to the one imaginary and two real values of α. The residual stresses at the cylindrical surface of the disk are small, and the displacement distribution of the plane surfaces agrees reasonably well with that obtained experimentally. A.

534.151

7187. An acoustic method for the measurement of vibration amplitudes. W. Koidan. *J. Acoust. Soc. Amer.*, **26**, 428–33 (*May*, 1954).

By means of a modification of the pistonphone, a technique has been developed to obtain the response of a capacitance type vibration pick-up probe using the reciprocity calibration of a condenser microphone as a reference. The raised, centre portion of a circular piston, driven by a barium titanate cylinder, projects into one end of a cavity, the shelf of the piston being located outside the enclosure. A calibrated condenser microphone coupled to the other end of the cavity responds to the sound pressure developed by the piston. The output of an annular capacitance type vibration pick-up, which detects the motion of the piston shelf, is compared with the generated microphone voltage. With the microphone removed from the cavity, the output of a capacitance probe located adjacent to the top surface of the piston is compared with that of the annular pick-up. The probe response is computed from these measurements and the microphone response. From considerations of checks by independent methods, an accuracy of about 0·5 db is indicated from 100 to 10 000 c/s. Using a sensitive probe, vibration amplitudes as small as 10^{-9} cm have been measured with a comparable degree of accuracy. A.

534.21 : 533.6.011.3

7188. An acoustic streaming experiment in gases. H. Medwin. *J. Acoust. Soc. Amer.*, **26**, 332–41 (*May*, 1954).

A radially symmetric progressive acoustic beam has been set up in a closed, gas-filled tube to cause streams driven by the Eckart, volume, source of vorticity. A careful determination of the acoustic pressure at all points of a cross-section of the beam has been used successfully to predict the stream velocities at this cross-section, for argon. The work with argon and the results of further experiments with dry nitrogen and moist air indicate that: (1) the Navier–Stokes equation, the equation of continuity and the acoustic "equation of state" $p_1 = \rho_1 c_0^2 + \beta\rho_1$, provide a valid basis for second-order studies of streaming; (2) thermal conduction effects may be introduced into the Eckart streaming equations in the same manner as they appear in the attenuation formulas; (3) the macroscopic quantity, bulk viscosity, is made up of contributions from the intramolecular processes of vibrational and rotational relaxation. A.

534.21 : 535.42

Diffraction of light by several ultrasonic beams: intensity of the combination lines. *See Abstr.* 7340

534.213

7189. On the correction for the end-effect in the non-linear region. P. N. Kubanskiĭ. Letter in *Zh. tekh. Fiz.*, **24**, *No.* 2, 348–9 (1954) *In Russian.*

Discusses the discrepancy between measured and calculated frequency for a resonator for large amplitude of vibration described previously [Abstr. 5908

(1953)]. It is suggested that for large amplitudes, the conditions at the aperture are such that there is a serious loss of energy and that Rayleigh's correction is inadequate. J. M. HOUGH

534.213.4

7190. Wave propagation in a viscous liquid contained in a flexible tube. G. W. MORGAN AND J. P. KIELY. *J. Acoust. Soc. Amer.*, **26**, 323–8 (*May*, 1954).

A theoretical analysis of the propagation of pressure waves through liquid-filled flexible tubes is presented. Expressions are derived which show the dependence of phase velocity and damping factor on the viscosity of the liquid, and on internal damping in the tube wall. The analysis is restricted to tubes with thin walls and to waves whose amplitude is infinitesimal and whose wavelength is large compared to the radius of the tube. A.

534.22/.23

7191. On the domain of dispersion, the velocity and absorption of ultrasonics in liquid, vitreous and crystalline glycerin. A. SCHULZ. *C.R. Acad. Sci.* [*Paris*] **238**, 1014–16 (*March* 1, 1954) *In French.*

Measurements with quartz crystals at temperatures down to −125°C are difficult due to the differing expansion coefficients of quartz and the glycerine. The difficulty has been overcome by transmitting through a glass cylinder which permits retention of the quartz at room temperature. As the temperature falls from 100°C the velocity increases slowly until about −30° to −35°C depending on frequency; the velocity then increases rapidly for a while, later returning to a slow rate again. The point of inflection is shown to coincide approximately with that of maximum dielectric loss. T. C. TOYE

534.22/.23

7192. Lamb's problem with internal dissipation. I. M. NEWLANDS. *J. Acoust. Soc. Amer.*, **26**, 434–48 (*May*, 1954).

A theoretical investigation is made of the response of an elastic half-space to a vertical impulse at the surface. Dissipative properties are incorporated in the medium and dissipation coefficients λ', μ' varying as the nth power of the frequency are assumed. These lead to dispersion and absorption. The response may be described by components of the three distinct types, *P*-, *S*- and *R*-. Each is observed at the surface as a train of waves culminating in a characteristic phase about the instants r/α, r/β and r/γ, respectively, where α, β and γ are the velocities of propagation of *P*-, *S*- and *R*- waves in nondissipative media and r is the focal range. These phases are discussed in detail; their "amplitude" and "span" are defined and the variations of each of these quantities and their ratios with r, density ρ and the material constants are derived. A schematic determination of λ and μ (the elastic constants), n, λ' and μ' from experimental data is outlined. A.

534.22/.23 : 538.63/.65

7193. Magnetic dispersion and attenuation of sound in conducting fluids and solids. R. A. ALPHER AND R. J. RUBIN. Letter in *J. Acoust. Soc. Amer.*, **26**, 452 (*May*, 1954).

It is shown that the general treatment by van de Hulst of the dispersion and absorption of sound arising from mechanical-electromagnetic coupling in conducting fluids immersed in magnetic fields applies directly to conducting elastic solids. A.

534.22/.23 : 612.844.4

7194. Acoustic properties of the refractive media of the eye. Z. E. BEGUI. *J. Acoust. Soc. Amer.*, **26**, 365–8 (*May*, 1954).

The density and viscosity of the refractive media of the eye have been measured. The velocity of propagation for 5 Mc/s sound waves is found to be 1497 m/sec for the aqueous humour, 1516 for the vitreous humour and 1616 for the lens. The absorption coefficient was determined at 30 Mc/s for the liquid part of the eye and at 3 Mc/s for the lens. A.

534.22

7195. The velocity of sound in hydrazine-water mixtures at 500 kilocycles. G. G. KRETSCHMAR. Letter in *J. chem. Phys.*, **22**, 753 (*April*, 1954).

Measurements have been undertaken to find whether discontinuities in the velocity-of-sound–concentration curve will occur in the region of the two eutectics for the hydrazine-water system. The curve was, however, found to be reasonably smooth although some anomalous behaviour was detected at one of these points, namely, about 69% hydrazine. More precise measurements are being planned. T. C. TOYE

534.22 : 532.7 : 539.13

7196. Thermal relaxation of vibrational states in sulfur hexafluoride. C. L. O'CONNOR. *J. Acoust. Soc. Amer.*, **26**, 361–4 (*May*, 1954).

The velocity of ultrasonic waves in sulphur hexafluoride (a symmetrical molecule with fifteen vibrational degrees of freedom) has been measured at frequencies of 251·22 kc/s and 1001·8 kc/s in the range from 0·38 to 15·89 Mc/s atmos^{-1} at 36·10°C. The observed dispersion in ultrasonic velocity is ascribed to the slow rate of energy exchange between translational and vibrational states. The dispersion region involves the disappearance of the whole of molecular vibrational energy, and corresponds to a single relaxation time. The relaxation time as derived from dispersion measurements is found to be $5{\cdot}89\times10^{-7}$ sec at one atmosphere corresponding to $4{\cdot}68\times10^{3}$ collisions required for energy exchange. The relaxation time for a sulphur hexafluoride mixture with 0·066 mole fraction of helium is found to be $5{\cdot}46\times10^{-7}$ sec. A.

534.22 : 539.13 : 541.68

7197. Sound velocity and chemical constitution. S. PARTHASARATHY AND N. N. BAKHSHI. *J. sci. industr. Res.*, **12A**, 448–53 (*Oct.*, 1953).

Although a lot of work has been done on the subject there is still no clear picture of the relation between sound velocity and chemical constitution. A review of the authors' work on sound velocities is made and it is concluded that the problem will need to be approached on the basis of intermolecular forces. A useful part of the review is the long list of separate conclusions which can be obtained from the various experimental results. 18 refs. T. C. TOYE

534.22 : 541.24

7198. Velocity of sound in liquids and molecular weight. S. PARTHASARATHY AND N. N. BAKHSHI. *J. phys. Chem.*, **57**, 453–4 (*April*, 1953).

A close examination of Rao's (1940) formula $v^{1/3}(M/\rho) = R$ reveals that in a modified form, it could be made use of in the determination of sound velocities in organic liquids. In the present work, it has been shown that if, instead of $v^{1/3}(M/\rho) = R$ against M, only $v^{1/3}/\rho$ is plotted against M, a family of curves is obtained for the homologous series. The general equation for the family of curves is of the type $v^{1/3}/\rho = A + B/M$ where $A = 13{\cdot}56$ is constant for all the series and B varies from series to series, while a plot of $v^{1/3}/\rho$ against $1/M$ shows that curves are transformed to straight lines, which diverge from the same point (0, 13·56). It has been tested for some homologous series. The calculated values of sound velocity from the new formulae have been compared with the observed values. The modified form suggests some remarkable regularities in the curves of different homologous series. A.

534.221

7199. Velocity of ultrasonics in methane under pressure. J. NOURY AND A. LACAM. Letter in *J. Phys. Radium*, **15**, 301 (*April*, 1954) *In French.*

Using the light diffraction method, the velocity-pressure relation is drawn for three different high frequencies. All the curves are parallel and continuous, each showing a gradual minimum at about 65 atm. T. C. TOYE

534.221

7200. Speed of a plane wave in a gross mixture. P. L. CHAMBRÉ. *J. Acoust. Soc. Amer.*, **26**, 329–31 (*May*, 1954).

The speed of a plane compression wave in a gross mixture (a suspension or a porous medium) which obeys a simple density mixture law is derived. The results agree with a relaxation proposed by Wood and others. The derivation of these investigators requires in addition to a density mixture law an assumption concerning the compressibility of the mixture in terms of the constituent compressibilities. It is shown that the latter assumption is a direct consequence of the density mixture law, and is hence not required. It is indicated that the derivation is applicable to waves of arbitrary amplitude. A.

534.222.1

7201. Propagation of sound in a statistically heterogeneous medium. L. A. CHERNOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 210–13 (1953) *In Russian.*

A differential equation is developed for the distribution function of rays in a medium endowed with random inhomogeneities; the medium is considered to be macroscopically homogeneous and isotropic. The irregular variations of the properties of the medium are assumed to take place at a fairly slow rate. Formulae are derived for the mean square of the deviation of a ray from its original direction.

F. LACHMAN

534.222.2

7202. Underwater explosion shock wave parameters at large distances from the charge. A. B. ARONS. *J. Acoust. Soc. Amer.*, **26**, 343–6 (*May*, 1954).

Experimental observations of peak pressure, decay constant and energy flux for TNT and pentolite are presented to ranges (in feet) defined by $R \simeq 2000W^{\frac{1}{3}}$, where W is charge weight in pounds. Previously published results extended only to $R \simeq 30W^{\frac{1}{3}}$. A.

534.222.2

7203. The initial propagation of spherical blast from certain explosives. F. J. BERRY AND M. HOLT. *Proc. Roy. Soc. A*, **224**, 236–51 (*June* 22, 1954).

The initial disturbance due to the detonation of an uncased spherical charge of explosive, initiated at its centre, is analysed in full. The equations of unsteady spherical motion are solved in the neighbourhood of the singularity at the origin of the air blast wave in the time-distance plane. Expansions are used in series of half-powers of the radial distance from this origin, with coefficients depending on the transverse co-ordinate. Two singular characteristics are found to start at this origin, and it is shown that the inner of these develops into a shock wave. This is identified as the secondary blast wave previously observed in experimental and numerical work. The wave is very weak at first with a strength which is zero initially and then begins to grow in proportion to the radial distance. In the present paper the explosive gas is assumed to be polytropic, with $\gamma = 3$, but the method developed can be extended to apply to any type of gas. A.

534.222.2 : 534.24

7204. Multiple shock reflection in corners. J. B. KELLER. *J. appl. Phys.*, **25**, 588–90 (*May*, 1954).

When a shock is incident upon a corner from either the concave or convex side it is reflected by the walls forming the corner and diffracted at the edge. The mathematical problem corresponding to this phenomenon has not been solved analytically except in the following limiting two-dimensional cases: a weak (acoustic) shock incident on any corner (Keller and Blank) and a finite shock incident either normal or parallel to a nearly flat wall (Bargmann, Lighthill, Ting and Ludloff). In this article it is pointed out that there are certain special cases of a finite shock entering a corner from the concave side in which no diffraction occurs. In these cases it is therefore possible to solve the entire problem by using the theory of regular reflection, which yields an explicit solution by algebraic means alone. A.

534.222.2 : 541.126

7205. Spherical propagation of detonation in acetylene-air mixtures. H. FREIWALD AND H. UDE. *Z. Elektrochem.*, **57**, *No.* 8, 629–32 (1953) *In German.*

Optical methods were used for following the propagation of the detonation of mixtures detonated in rubber balloons of 90–2500 litres. The existence of reflected spherical waves after detonation was established. F. LACHMAN

534.222.2 : 541.126

Chemical reactions in strong shock waves. *See Abstr.* 7813

534.23

7206. Absorption of ultrasonics in mixtures of helium-argon. S. PETRALIA. Letter in *Nuovo Cimento*, **11**, 570–1 (*May*, 1954) *In Italian.*

Results obtained with an interferometer for the variation of α/f^2 with f/p where α is the absorption

coefficient, f the frequency and p the pressure are shown graphically for A; at 10 Mc/s atm the value of α/f^2 is closely $190 \cdot 10^{-15}$ cm^{-1} sec^2. Values of α/f^2 as a function of concentration for the mixture He–A are also shown graphically. Measurements were made for pressures between 15 and 40 cm Hg. α/f^2 is a maximum for the concentration 50% A 50% He. The values are compared with those calculated from Enskog's relation for α. S. WEINTROUB

534.23 : 534.833.4

7207. Sound absorption by perforated porous tiles. I. U. INGARD. *J. Acoust. Soc. Amer.*, **26**, 289–93 (*May*, 1954).

Several theoretical studies of the acoustic properties of homogeneous isotropic porous material have been presented in the past, and the results have been shown to be in good agreement with experiments. However, no corresponding satisfactory theoretical analysis of the commonly used perforated porous tile seems to have been given. In this paper this problem is treated in some detail, and from the resulting formulas and equivalent circuits the acoustic properties of the tile can be calculated in terms of the geometry and the properties of the porous material. As an example, the acoustic impedance and absorption coefficient have been calculated as a function of perforation depth for a typical tile, and the results are shown to be in good agreement with measurements. A.

534.232

7208. The electro-acoustic sensitivity of cylindrical ceramic tubes. R. A. LANGEVIN. *J. Acoust. Soc. Amer.*, **26**, 421–7 (*May*, 1954).

Increasing use is being made of cylindrical barium titanate tubes as underwater acoustic transducers. An exact derivation is given for the low-frequency acoustic sensitivity of such tubes for a variety of boundary and polarization conditions. A.

534.232 : 534.321.9 : 621.395.616 : 621.395.623.7

7209. Condenser loudspeaker for high frequencies, and condenser microphone, with solid dielectric. W. KUHL. *Acustica*, **4**, *No.* 1, 82–3 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Counter-electrodes with grooves or holes and having stretched over them thin layers of plastic foil metalized on the outside can serve as condenser loudspeakers, whose frequency response depends on the form of the counter-electrode and whose efficiency even on low potential exceeds that of dynamic loudspeakers above 5 kc/s. Condenser microphones of this type have nearly the same sensitivity as those with an air dielectric in the audio range but much greater sensitivity in the ultrasonic range. A.

534.232 : 534.6 : 621.395.623.7.001.4

7210. Conditions for acoustical testing of loudspeakers. P. CHAVASSE AND R. LEHMANN. *Acustica*, **4**, *No.* 1, 66–70 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Measurements made on loudspeakers have to be delicate and demand high-quality apparatus in a special laboratory. With the object of standardizing measurements in different laboratories, often difficult to compare, the procedure to be adopted for the following measurements is laid down, viz. frequency characteristic in steady state, directivity, harmonic distortion, intermodulation, impedance characteristic, output, transient response. A.

534.232 : 621.3.012.8 : 621.317.332 : 621.372.412

7211. Determination of equivalent-circuit constants of piezoelectric resonators of moderately low Q by absolute-admittance measurements. G. E. MARTIN. *J. Acoust. Soc. Amer.*, **26**, 413–20 (*May*, 1954).

The use of absolute-admittance measurements has been limited in the past to the determination of parameters of relatively high-Q resonators. By allowing only one major assumption in the analysis of the resonator, new equations are developed which consider the mechanical loss to be a first-order effect. On the basis of extensive numerical calculations of resonator characteristics in which no approximations were made, the errors of both the conventional relationships and the new equations are made evident. These new equations extend the usefulness of this method of measurement to include systems for which the mechanical Q is lower than the capacitance ratio. For the extreme case exemplified by a Ba titanate ceramic resonator in air, the conventional calculation method introduces errors of $\sim$50% in some of the crystal parameters as compared to errors of 1% for the new equations. The improvement is less significant in the determination of the parameters of underwater sound transducers. A.

534.232 : 621.395.623.7

7212. Advances in the development of loudspeakers. G. BUCHMANN. *Acustica*, **4**, *No.* 1, 63–6 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Attempts to improve electrodynamic loudspeakers used for broadcasting lead to a membrane with quasi-parabolic trace. Damping applied to the edges smooths out the frequency responses and reduces the subharmonic content. The current in the coil reacts back on the magnetic field which produces nonlinear distortion. The forces set up in the membrane can cause amplitude modulation. A.

534.232 : 621.395.61

7213. The design of high fidelity microphones. M. L. GAYFORD. *Acustica*, **4**, *No.* 1, 73–4 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The principles of microphone design are illustrated by the analysis of a modern moving-coil microphone. A description is given of the derivation and use of an improved analogous electrical circuit which takes into account the effects of portions of the diaphragm both inside and outside the speech coil diameter. A.

534.232 : 621.395.623.7

7214. A new electro-acoustic transducer: the ionophone. S. KLEIN. *Acustica*, **4**, *No.* 1, 77–9 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Describes a new French loudspeaker without membrane and its uses in music reproduction and for ultrasonics. A.

534.242

7215. Absorbent systems for sound with neckless resonators. A. GIGLI. *Atti Rass. tecn. Soc. Ingegn. Archit. Torino*, **6**, 227–30 (*Aug.–Sept.*, 1952) *In Italian.*

Describes experiments performed to verify that Helmholtz's formula holds for the resonant frequency for the type of resonators which are formed when a perforated sheet is spaced off from a wall. The experiments were performed in a Kundt's tube and good agreement was obtained with theory.

J. M. HOUGH

534.26

7216. Diffraction of sound waves by a prolate spheroid. J. AWATANI. *J. Inst. Elect. Commun. Engrs Japan*, **35**, 407–9 (*Sept.*, 1952) *In Japanese.*

The sound pressures at various points on the surface of the spheroid due to a plane sound-wave train incident in the direction of the long axis of the spheroid are calculated.

A. WILKINSON

534.321

7217. Subjective musical pitch. W. D. WARD. *J. Acoust. Soc. Amer.*, **26**, 369–80 (*May*, 1954).

The subjective relation "octave of" is demonstrated to be a valid interval for determining scales of musical pitch for pure tones presented successively. Octave judgments of trained musicians have a standard deviation averaging about 0·6%. Inter-observer variability is 2 to 5 times as great, increasing with frequency. Judgments vary significantly from day to day, but as the direction of shift at different frequencies for a single observer is random, the shifts cannot be attributed to changes in the octave criterion. Instead, this variability, and also (1) differences between right- and left-ear judgments of a given observer, (2) the change in difference between subjective and physical octaves as a function of frequency and (3) the high inter-observer variability, all confirm the basic instability of pitch-frequency relations implied by the facts of binaural diplacusis. Individual and group scales of musical pitch are deduced. In these scales, the average rate of change of musical pitch with respect to frequency level is less than unity by a small but significant amount. Although this discrepancy is not explained, tests show that it is not an obvious artifact of method. Simultaneous presentation raises variability, but affects means only slightly. The relation between the peculiarities of individual scales and binaural diplacusis is discussed.

A.

534.321.71 : 534.232 : 621.389

7218. Electronic tuners for musical pitch. J. J. GELUK. *Acustica*, **4**. *No.* 1, 220–3 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The stability of electronic oscillators has surpassed the accuracy of mechanical tuning devices; especially in respect to temperature variations the electronic oscillators can be given almost a completely stable frequency. Even with great limitation in circuit parts and costs, the constancy of the frequency can be made better than that of a steel tuning fork. Nowadays simple electronic devices can be made according to the international standard of musical pitch.

A.

534.321.9 : 621.374.5

7219. Metal ultrasonic delay lines. R. W. MEBS, J. H. DARR AND J. D. GRIMSLEY. *J. Res. Nat. Bur. Stand.*, **51**, 209–20 (*Nov.*, 1953).

The applicability of a number of metals and alloys for thermally stable ultrasonic delay lines was studied. A preliminary investigation was made of different types of pressure holders and adhesives for use in crystal transducer attachments and of the influence of specimen length on attenuation for various metals and alloys. The effect of cold-work, annealing and specimen cross-section on attenuation was also determined for a representative isoelastic alloy. Measurements of temperature variation of signal attenuation, distortion and delay time on a number of assembled delay lines indicated that an isoelastic alloy employing overcured epoxy-resin crystal attachments gave best over-all transmission characteristics. No correlation was obtainable between strength and sound-transmission characteristics with various cemented joints.

A.

534.321.9 : 621.395.62

7220. Characteristics of ultrasonic delay lines using quartz and barium titanate ceramic transducers. J. E. MAY, JR. *J. Acoust. Soc. Amer.*, **26**, 347–55 (*May*, 1954).

Previous analysis of the equivalent circuit for the ultrasonic delay line was applied to quartz crystal transducers and a vitreous silica delay medium. The analysis has been extended to evaluate the use of other materials such as magnesium, aluminium and steel, and to include $BaTiO_3$ ceramic transducers. Calculations show the decrease in loss to be expected as the impedance of the delay medium is decreased and conversely the increase in band width to be expected as the impedance of the delay medium is increased. The increase in band width resulting from symmetrical loading of the transducers is also evaluated. Modifications to the equivalent circuits for the case of $BaTiO_3$ ceramic transducers are considered. Theoretically losses can be reduced to 10 db or less using the ceramic transducers with a vitreous silica medium. The band width is slightly less than for quartz crystal transducers. However, by utilizing higher impedance materials, band widths approaching 100% should be achieved.

A.

534.322.3 : 532.528

7221. Ultrasonic spectrum of cavitation noise in water. R. H. MELLEN. *J. Acoust. Soc. Amer.*, **26**, 356–60 (*May*, 1954).

The acoustic noise spectrum associated with the collapse of transient cavities produced by a stirring rod in water was measured in the frequency range 1–3500 kc/s. While the spectrum, in general, goes as f^{-2} above 1 kc/s, flat regions are found between 20 kc/s and 100 kc/s, and again above 500 kc/s to at least 3500 kc/s. If the flat regions are due to discrete random impulses, two time constants, $\tau_1 \simeq 10^{-6}$ second and $\tau_2 < 10^{-8}$ second, may be obtained by using the criterion $2\pi f\tau \simeq 1$, where f is the -3 db point beyond the flat region. With intense cavitation, the acoustic level falls off and becomes erratic in the 600 kc/s region. Transmission measurements made through the cavitating volume show strong sound absorption, which appears to be caused by a cloud of small, stable bubbles.

A.

534.372

7222. An instrument for the measurement of damping capacity. K. MÍŠEK. *Czech. J. Phys.*, **4**, 67–87 (*Feb.*, 1954) *In Russian.* Summary (2 *pp.*) *in English.*

Apparatus is described for measuring the longitudinal, transverse and torsional vibrations of cylindrical rods at temperatures up to 600°C. The vibrations are excited and detected by electrostatic means and the logarithmic decrement is registered with a valve voltmeter. Careful attention is paid to the method of supporting the rods and to the design of the electrical circuits. The results of measurements of the log-dec. in air and *in vacuo* for Al and steel are described and it is shown that, for rods of given length, losses in the pick-up circuit are solely responsible for the dependence of the decrement on the rod diameter for Al and mainly responsible for it in steel. The effect on the damping of heat treatment of steel and Al and of corrosion of steel and brass is described. H. J. H. STARKS

534.44 : 534.78 : 621.395.623

7223. Design of visible speech devices. G. E. PETERSON. *J. Acoust. Soc. Amer.*, **26**, 406–13 (*May*, 1954).

The conventional sound spectrograph affords the analysis of short signal samples and considerable flexibility in the construction of amplitude sections. Other major interests in sound spectrography are in the instantaneous portrayal of signals, and in the permanent record display of continuous linear and logarithmic analyses. This paper suggests instrument methodology for carrying out these operations. Values which are considered practical are suggested for the parameters of certain of the systems which are discussed. A.

534.6 : 534.231

7224. On small ultrasonic probes in sound field measurement in liquids. G. BOLZ. *Z. angew. Phys.*, **6**, *No.* 2, 54–9 (1954) *In German.*

In precise measurement it is necessary that the measuring probes shall be small compared with the wavelength. A theoretical and experimental study proves the advantages of tourmaline and barium titanate in this respect as well as the unsuitability of quartz and Rochelle salt. T. C. TOYE

534.6 : 534.773 : 621.395.92.08

7225. An artificial voice and miniature anechoic chamber for hearing aid measurements. R. W. CARLISLE. *J. Acoust. Soc. Amer.*, **26**, 389–90 (*May*, 1954).

There is described an enclosure for a standard loudspeaker mechanism which provides a compact sound source or artificial voice. With a size slightly larger than a human head, the frequency range is 100 to 7000 c/s. A simple and reproducible arrangement of damping felt gives unusual flatness. This artificial voice can either be used in free space or with a small chamber arranged as an acoustic labyrinth, for testing microphones and hearing aids. In the chamber, a calibrating microphone is mounted opposite the test microphone for continuous monitoring. Simple RC compensating networks are utilized to equalize the sound source for either free-space or labyrinth measurements. A.

534.61/.62

7226. Determination of absolute sound levels and acoustic absorption coefficients by thermocouple probes—theory. W. J. FRY AND R. B. FRY. *J. Acoust. Soc. Amer.*, **26**, 294–310 (*May*, 1954).

A detailed theoretical analysis of the operation of thermocouple probes used to determine absolute sound levels or acoustic absorption coefficients is presented. The probe consists of a thermocouple imbedded in a sound absorbing medium which closely matches in density and sound velocity the medium in which the sound level is to be determined. In use the transducer which generates the acoustic field is excited to generate sound pulses with a rectangular envelope. The initial time rate of change of the temperature at the thermocouple junction is determined. In addition to the measurement of the temperature change, the calculation of the absolute sound intensity requires only a knowledge of the absorption coefficient of the imbedding material and its heat capacity per unit volume at the temperature at which the measurements are made. The theoretical discussion includes an analysis of the relation between the temperature rise at the junction resulting from absorption in the body of the imbedding medium and the sound level. In addition, the effects of (*a*) viscous forces arising from relative motion between the thermocouple and the imbedding fluid, and (*b*) heat conduction between the thermocouple and the fluid, in contributing to the temperature change at the thermocouple junction are analysed. Based on the analysis, a set of design formulas is obtained which are summarized and illustrated for the convenience of other investigators who may wish to design and use such probes. A.

534.61/.62

7227. Determination of absolute sound levels and acoustic absorption coefficients by thermocouple probes—experiment. W. J. FRY AND R. B. FRY. *J. Acoust. Soc. Amer.*, **26**, 311–17 (*May*, 1954).

A stable, readily constructable thermocouple probe has been developed for determining absolute sound levels in ultrasonic fields in liquid media. This paper includes criteria for design of such probes and a discussion of experimental measurements made with such a device. It is a consequence of the method that if the sound intensity at an appropriate size thermocouple junction imbedded in an absorbing medium is known the acoustic absorption coefficient of the material can be determined. The method thus makes possible the determination of absorption coefficients of minute quantities of material. The probe consists of a thermocouple imbedded in a sound-absorbing medium which closely matches in density and sound velocity the medium in which the sound level is to be determined. In use the transducer which generates the acoustic field is excited to generate sound pulses with a rectangular envelope. The initial time rate of change of the temperature at the thermocouple junction is determined. In addition to the measurement of the temperature change, the calculation of the absolute sound intensity requires only a knowledge of the absorption coefficient of the imbedding material and its capacity per unit volume at the temperature at which the measurements are made.

The experimental results include a comparison of the sound level determined by a thermocouple probe and a determination by radiation pressure methods. The values obtained by the two methods agree within the uncertainty of the experimental measurements. A.

534.612

7228. Transducer output by reaction measurements. E. F. KIERNAN. *J. Acoust. Soc. Amer.*, **26**, 451 (*May*, 1954).

Sound power output of a plate type transducer is obtained by measuring the reaction force on the transducer. A.

534.612.2 : 621.395.61.089.6

7229. Recent work at the National Physical Laboratory on the free-field calibration of standard microphones. R. S. DADSON AND E. G. BUTCHER. *Acustica*, **4**, *No.* 1, 103–5 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Recent developments at the National Physical Laboratory on free field standards of sound pressure and microphone calibration are described. In the l.f. region free field plane-wave conditions are difficult to achieve in conventional absorbent rooms, and this has been met by the installation of a large duct in which truly plane progressive waves may be generated down to 25 c/s. At the higher frequencies the Rayleigh disk and reciprocity free-field standards have been compared and show excellent agreement. A.

534.612.2 : 621.395.61.089.6

7230. Absolute calibration of microphones at audible and ultrasonic frequencies. V. GAVREAU. *Acustica*, **4**, *No.* 1, 105–7 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The ultrasonic piston-phone is formed of the upper end of a massive metallic cylinder vibrating at a half wavelength. The intensity of the sound produced is calculated either from the amplitude of vibration optically measured or from the pressure of radiation measured on a balance. The reciprocity method at high audio-frequencies requires the use of a pressure chamber closed by a cap with a small hole. The classical formula is modified to take account of the effect of the baffle. A.

534.612.2 : 621.395.616

7231. Noise in condenser microphones. A. G. T. BECKING AND A. RADEMAKERS. *Acustica*, **4**, *No.* 1, 96–8 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. It is pointed out that the mechanical resistance, used for damping a simple mechanical oscillator, acts as the source of a fluctuating force with spectral intensity $4RkT$. In the case of a condenser microphone this results in a noise pressure on the diaphragm, which lies in the region of audible sound pressures. Experimental results, obtained with two microphones, agree well with the theory. A.

534.612.2 : 621.395.616

7232. Laboratory standard microphones. R. K. COOK. *Acustica*, **4**, *No.* 1, 101–3 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The condenser microphone is successful as a laboratory standard, mainly because it is particularly amenable to calibration by the reciprocity technique. An electro-acoustic analysis of its action is presented here in terms of lumped parameters, which are deduced from measurements of response and electrical admittance. This suggests a new method for extending response determinations to higher frequencies, requiring only admittance measurements and a quarter-wave tube, in addition to a knowledge of the response at lower frequencies. A.

534.614

7233. A combined time and phase demodulation method for measuring wave velocities with commercial ultrasonic equipment. H. SCHMAUCH AND W. BENTZ. *Z. angew. Phys.*, **6**, *No.* 4, 168–71 (1954) *In German.*

A simple modification of the usual type of ultrasonic impulse equipment is described whereby the errors of measurement may be reduced to appreciably less than 1 cycle of the carrier frequency. The results of measurements of the wave velocities in distilled water and in water-alcohol mixtures are given. Reference is also made to the suitability of the method for making accurate measurements of the longitudinal and transverse wave velocities in solids.

H. J. H. STARKS

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 7946–9

534.773 : 389.6 : 621.395.92

7234. The standardization of hearing aids in France. P. CHAVASSE AND R. LEHMANN. *Acustica*, **4**, *No.* 1, 147–51 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. In France since June 1952, besides dimensions of batteries and plugs, standards have been laid down for: resistance to vibration, heat and humidity; minimum gain; definition of response curve; harmonic distortion. The background threshold of an aid is also measured. A.

534.773 : 534.232 : 621.395.62

7235. Contribution to the problem of the artificial ear. A. LONCHEVAL. *Acustica*, **4**, *No.* 1, 161–5 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. With the variety of couplers used for artificial ears in practice, a wide difference in results is obtained with the same receiver which makes results of different laboratories not comparable. To obtain trustworthy response curves for telephone receivers an artificial ear having the same characteristics as the human ear has been constructed and the impedance and response curves of natural ears have been determined. These results agree with those of the new artificial ear. A.

534.773 : 534.232 : 621.395.92

7236. Artificial ear design criteria. W. W. LANG. *Acustica*, **4**, *No.* 1, 159–61 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The performances of four earphone calibrators are evaluated by comparing the pressures inside the

artificial ears with those developed by the same earphone inside 24 human ears. The design of an artificial ear is discussed. The instrument of simplest design appears to be as useful for calibration purposes as the more complicated devices. A.

534.773 : 621.395.92

7237. A discussion of some problems involved in deriving objective performance. Criteria for a wearable aid from clinical measurements with laboratory apparatus. E. W. Ayers. *Acustica*, **4**, *No.* 1, 141–3 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. An investigation of the effects of frequency-response characteristics on the performance of hearing aids is described. In translating the results of experiments into a performance specification for a wearable aid, it is necessary to make allowances for differences in the relationships between the subjective and objective efficacies of the transducers used, and for the special conditions of use. The microphone of the aid is normally worn on the body of the user, possibly under one or more layers of clothing, and is exposed to a partially diffuse sound field. The paper discusses some of these effects, and shows how the appropriate correcting factors may be determined. A.

534.773 : 621.395.92

7238. The upper frequency limit in hearing aids. W. Güttner and C. Starke. *Acustica*, **4**, *No.* 1, 155–8 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. It is the object of the development of high-fidelity reproduction to widen the frequency band of reproduction. In the past the upper limit was about 2·5 kc/s, limited by the microphones and earmoulds used but an extension to 4·6 kc/s is possible if the acoustic units in previous constructions are improved and open earmoulds adopted. A.

534.773 : 621.395.92

7239. The desired performance of hearing aids. H. Mol. *Acustica*, **4**, *No.* 1, 168–70 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Successful application of a hearing aid depends on the dynamic properties of the ear. The ossicle chain must be regarded as a regulating mechanism that is brain-controlled by means of the stapedial muscle. Special difficulties arise when the dynamic range of the basilar membrane itself is diminished. In principle, a hearing aid with automatic gain control can never fully restore the impaired dynamic behaviour of the ear. A.

534.773 : 621.395.92.08

7240. Methods of measurement for hearing aids. A. G. T. Becking. *Acustica*, **4**, *No.* 1, 143–5 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The different ways of defining the input sound pressure on a hearing aid are discussed. In addition, a comparison is given of the specifications for acceptable hearing aids in some European countries. A.

534.781

7241. On the identification of speakers by voice. I. Pollack, J. M. Pickett and W. H. Sumby. *J. Acoust. Soc. Amer.*, **26**, 403–6 (*May*, 1954).

The effect of several factors upon voice identification was examined. These factors were: the size of the class of possible voices, the duration of the speech signal, the frequency range of the speech signal, voicing *v.* nonvoicing speech characteristics and the simultaneous presentation of several voices. One of the most effective factors for speaker identification was the duration of the speech signal. Duration, as such, appears to be important, however, only insofar as it admits a smaller or larger statistical sampling of the speaker's speech repertoire. A.

534.792

7242. Loudness relations in two-component tones. A. M. Small, Jr, and W. R. Thurlow. *J. Acoust. Soc. Amer.*, **26**, 381–8 (*May*, 1954).

A two-component tone was presented under a number of frequency and intensity conditions. The loudness of each component and the total loudness of the combination were traced as the intensity of the higher frequency and were brought from masked threshold to well above masked threshold. Loudnesses were determined by equating the tone or tones under consideration to a comparison tone. When the higher frequency of the pair was at or below 1000 c/s, it showed a loudness loss, relative to its loudness when presented alone, at medium intensities above its masked threshold; but as its intensity was increased, it tended to regain its normal loudness. When the higher frequency of a pair was above 1000 c/s, it exhibited a greater than normal loudness at medium intensities above its masked threshold which again approached normal with increased intensity. The lower frequency of a pair seemed to be little affected by increases in the intensity of the higher frequency within the limits of intensity used. Total loudness tended to be the algebraic sum of the components' loudnesses. The results indicate that the effect of a tone upon the loudness of another is not so simple a phenomenon as a tone's effect upon the threshold of another. A.

534.833 : 621.395.721.2

7243. Acoustic factors in the design of noise-reducing telephone booths. D. E. Bishop, F. G. Hewitt and D. B. Callaway. *J. Acoust. Soc. Amer.*, **26**, 318–22 (*May*, 1954).

The principal factors determining the noise reduction of an acoustically treated, doorless booth (where the noise reduction is considered as the decibel difference in octave band noise levels measured outside and inside the booth) have been investigated by use of full size and $\frac{1}{3}$ model booths. The principal parameters affecting the reduction were found to be (1) the absorption coefficients of the wall surfaces as a function of frequency; (2) the ratio of open area to wall area; (3) the transmission loss of the walls; and (4) the size and shape of the booth. The investigation resulted in a new triangular design of booth which is fully as effective acoustically as the rectangular booths, yet has added practical advantages. A.

534.861.1 : 534.862.1 : 621.396.712.3

7244. Room-acoustic diffuseness in sound recording and radio studios. W. Furrer and A. Lauber. *Acustica*, **4**, *No.* 1, 29–33 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The homogeneity of a sound field in a room, which is called "diffuseness," plays an important part in radio and sound recording studios. Earlier investigations have already shown that the "mean height of a peak" of the frequency response of a room is a suitable index of diffuseness. The determination of this quantity from the frequency response is, however, so laborious that a special measuring apparatus had to be developed, ensuring quick and easy measurement. A.

534.862.3 : 621.395.625.3

7245. Some recent developments in magnetic recording. M. Camras. *Acustica*, **4**, *No.* 1, 26–9 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Trends in magnetic recording take advantage of its erasability, fast response, and high resolution. Examples of recent developments are: high-output magnetic tapes, the magnetic modulator head, the "time-compressor," half track recording, and magnetic contact printing. A.

534.862.3 : 621.395.625.3

7246. The characteristic properties of magnetic sound records in relation to the conditions of operation and the properties of the sound carrier. H. Schiesser. *Acustica*, **4**, *No.* 1, 41–4 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The fundamental influence of the form of the characteristic on sensitivity, level, frequency response, nonlinear distortion, background noise, printing-effect and erasure is pointed out and its relation to the physical properties of the tape determined experimentally. A.

534.862.4 : 621.395.625.3

7247. Application of the reciprocity theorem to magnetic reproducing heads. W. K. Westmijze. *Acustica*, **4**, *No.* 1, 50–2 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. It is shown that the output of a magnetic reproducing head can be calculated if the field distribution in front of the head is known for the case when the latter is energized. Application of this method enables one to predict the response curve of a wide-gap head and to explain the existing difference between wide-gap and narrow-gap measurements. A.

534.862.4 : 621.396.62

7248. The radio set as an instrument for the reproduction of music. J. Rodrigues de Miranda. *Acustica*, **4**, *No.* 1, 38–41 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The following conditions should be satisfied: (1) Distortion should be decreased as the h.f. range increases. (2) Means are desirable for adjusting bass response, for cutting off and for gradual attenuation of treble. (3) The electro-acoustical engineer and the architect should co-operate closely. The cabinet must be rigid, the loudspeaker placed forward; its cloth chosen carefully. (4) The speaker should be chosen in accordance with the acoustical properties of the cabinet. The a.f. characteristic of the receiver should be carefully determined. A.

OPTICS . RADIATION . SPECTRA 535

535.231.4

7249. Approximate emissivity calculations for polyatomic molecules. I. CO_2. S. S. Penner. *J. appl. Phys.*, **25**, 660–7 (*May*, 1954).

Approximate emissivity calculations for CO_2 have been carried out, as a function of optical density, at 300 and at 600°K. The calculations involve the assumption that the rotational lines overlap extensively. This condition appears to be satisfied at total pressures above about 1 atm. Comparison of the values calculated from spectroscopic data with the emissivities tabulated by Hottel and his collaborators shows satisfactory agreement. The analysis presented emphasizes the fact that it is possible to obtain reasonable estimates for the engineering emissivity without performing extensive analytical work, provided the physical principles are understood and the needed spectroscopic data are available. A.

535.24 : 621.327.4

7250. Photometric measurements on fluorescent and discharge lamps. G. Parolini. *Elettrotecnica*, **40**, 660–79 (*Dec.*, 1953) *In Italian.*

After a general treatment of the problems of heterochromatic photometry, the methods now usually adopted, including the flicker method, are described. The effect of size of source on photometric measurements is treated briefly. The second part describes the photometric equipment in the Institute of Technical Physics at Rome and gives a detailed account of an extensive series of measurements (15 000) of luminous intensity and flux made by various methods on 19 different types of lamp. The results are discussed and it is concluded that with visual methods an accuracy of $\pm 5\%$ may be expected. J. W. T. Walsh

535.243 : 621.327.3

7251. Spectrophotometric measurements on high-pressure mercury vapour lamps. G. Parolini. *Ingegnere*, **28**, 253–8 (*March*, 1954) *In Italian.*

After a description of the various types of high-pressure and medium-pressure Hg vapour lamps, with tables showing the colour of the light produced by the commonly used phosphors, the author tabulates, for 7 different types of lamp, including 4 of the low-pressure Hg fluorescent class, the percentage flux emitted in 12 spectral bands. The measurements were made with a König–Martens spectrophotometer. J. W. T. Walsh

535.245

7252. A simple daylight factor meter. J. Longmore and R. G. Hopkinson. *J. sci. Instrum.*, **31**, 214–17 (*June*, 1954).

An instrument based on a commercially available

foot-candle meter is described. An adjustable sensitivity device enables the reading to be set to a fixed value when the instrument is directed towards the open sky, thus fixing the denominator of the daylight factor fraction. With the sensitivity set in this way, the instrument is taken indoors where it reads in terms of daylight factor. The instrument is direct reading between 0 and 6% daylight factor and gives adequate accuracy for practical purposes with skies whose brightness is 600 foot-lamberts and upwards. Range scales are provided for conditions of higher daylight factor and these also enable readings to be made with skies whose brightness is below 600 foot-lamberts. A.

535.247 : 541.182.3

7253. Densitometric evaluation of coal-dust stains on filter paper. J. G. Dawes. *Brit. J. appl. Phys.*, **5**, 221–4 (*June*, 1954).

The theory of Davies and Aylward [Abstr. 1613 (1952)] for interpreting the light-screening power of deposits of coal-dust on a uniform filter paper is extended, and the modified theory is tested using data from samples taken in a dust tunnel. A.

535.315

7254. On the effect of curvature of lines on the resolving power of a prism. M. S. Sodha. Letter in *J. sci. industr. Res*, **12 B**, 563–4 (*Nov.*, 1953).

The curvature of spectral lines arises from the finite length of the slit. For points away from the centre of the slit, rays traverse the prism in oblique sections, so that the optical path length is increased. The resolving power is found to be a minimum at the centre, increasing slowly to the ends. The increase for large angle prisms is shown to be appreciable. R. W. FISH

535.317

7255. Achromatic combination of two lenses separated by a distance. M. V. R. Krishna Murty. Letter in *Curr. Sci.*, **22**, 369–70 (*Dec.*, 1953).

An error is pointed out in a previous paper [Abstr. 1135 (1954)] and the correct conditions for achromatism are given. The corrected equations are shown to agree with the simple form used in eyepiece design. R. W. FISH

535.317.1

7256. The idea of coherence in optics. A. Blanc-Lapierre and P. Dumontet. *C.R. Acad. Sci.* [*Paris*] **238**, 1005–7 (*March* 1, 1954) *In French.*

Gives precise definitions, in the case of non-monochromatic sources, of the terms coherent, incoherent and partially coherent. The mathematical conditions are stated for the three cases. R. W. FISH

535.317.1

7257. Discussion of a general system, applicable in particular to the theory of image formation of partially coherent objects. P. Dumontet. *C.R. Acad. Sci.* [*Paris*] **238**, 1109–11 (*March* 8, 1954) *In French.*

The general process of making an observation is systematized and a mathematical procedure for dealing with the system outlined. The method is applied to an optical system, considered as a linear filter, forming an image with incoherent and partially coherent light. R. W. FISH

535.317.25 : 771.534.55

7258. The resolving power of an "objective-emulsion" combination. V. Blumová and J. Hrdlička. Letter in *Czech. J. Phys.*, **4**, 95 (*Feb*, 1954) *In French.*

Some general relationships are given between the resolving power of a system and the object contrast, time of exposure, viewing conditions and position of focus. R. W. FISH

535.32 : 539.23

7259. A new method for the rapid, approximate determination of the optical constants and thickness of a thin absorbing film. F. Abelès. *C.R. Acad. Sci.* [*Paris*] **238**, 881–3 (*Feb.* 22, 1954) *In French.*

The complex refractive index of a thin film and its thickness can be found rapidly from the positive root of a quadratic equation involving the reflection coefficients and transmission of the film. A simplified equation is also given for the case of a highly absorbing film. Comparison of the values derived for a gold film by this and a more exact method shows that the results are within the limits of experimental error. R. W. FISH

535.321

7260. A new optical system for simultaneous recording of refractive index and its gradient in stratified solutions. H. Svensson and R. Forsberg. *J. Opt. Soc. Amer.*, **44**, 414–16 (*May*, 1954).

A new method for simultaneous production of records of refractivity and its gradient in liquid columns is presented. It is based on the use of a specially designed cell with one plano-parallel part, where the light is vertically deflected according to the local value of the gradient, and one prismatic part, in which the light suffers a lateral deflection according to the local refractivity value. A.

535.323 : 535.345 : 539.234

7261. Optical properties of thin films of cadmium sulfide. J. Gottesman and W. F. C. Ferguson. *J. Opt. Soc. Amer.*, **44**, 368–70 (*May*, 1954).

Thin evaporated films of CdS on glass were studied in the wavelength range 4000 to 7500 Å. Measurements of film thickness and reflectivity as a function of wavelength were used to determine the index of refraction and the extinction coefficient. Density measurements and ageing tests were also carried out. The effects on film properties of a variation of the rate of deposition were investigated. A.

535.323 : 535.41

7262. The determination of the optical parameters of an opaque metallic film by means of goniophotometric measurements. F. Abelès and S. Creignou. Letter in *J. Phys. Radium*, **15**, 303–4 (*April*, 1954) *In French.*

The complex refractive index of a film of chromium is determined from the variation of the reflection coefficients with angle of incidence. The thickness of the film so found is shown to agree with that obtained by other methods. R. W. FISH

535.323 : 539.234

7263. Optical constants of silver, gold, copper, and aluminum. II. The index of refraction *n*. L. G. SCHULZ AND F. R. TANGHERLINI. *J. Opt. Soc. Amer.*, **44**, 362–8 (*May*, 1954).

For Pt I, see Abstr. 7311. The reflectivities of Ag, Au, Cu, and Al were measured at an angle of incidence of 45°, in the wavelength range of 0·40 μ to 0·95 μ at glass-metal and air-metal interfaces. These reflectivities, together with values of the absorption coefficient k (see Pt I), were used to calculate the index of refraction n. Samples were prepared by evaporation and deposition from the vapour. The important experimental results are: (1) The ratios of the reflectivities in the s plane to those in the p plane agreed with the theoretical values. This result indicates that the boundary conditions required for the application of the equations of electromagnetic theory have been satisfied. (2) Ageing and annealing resulted in increased reflectivity at both air-metal and glass-metal interfaces. (3) The values of n obtained from aged or annealed samples were in many cases considerably lower than previously published values. A.

535.324.2

7264. Refractive index of mixtures of carbon tetrachloride and benzene. P. K. KATTI AND V. N. WANCHOO. *Sci. and Culture*, **19**, 416–17 (*Feb.*, 1954).

The average refractive index of a mixture could be represented by a linear relationship if the two components behave completely independently of each other in the mixture. In practice a small correcting term is necessary, dependent upon the product of the volume fractions of the two components. R. W. FISH

535.33

7265. Spectroscopy from the point of view of communication theory. IV. Automatic recording of infrared spectra on punched cards. G. W. KING, E. H. BLANTON AND J. FRAWLEY. *J. Opt. Soc. Amer.*, **44**, 397–402 (*May*, 1954).

For Pt III, see Abstr. 8311 (1953). It is desirable to record infrared spectra point by point in digital form on punched cards in order to use automatic-machine methods of processing the data; for example, in calibration, conversion to absorption coefficient, comparison of spectra, subtraction of spectra of an identified constituent from that of an unknown mixture. Recording spectra in this way also allows the introduction of new methods suggested by communication theory of improving signal-to-noise ratio by smoothing noisy data with correlation functions. In applying these methods the computing machine can be considered as a nonlinear filter, part of the infrared equipment. The punched-card record is made by attaching to the output of the detector voltage amplifier a Digital Reader in parallel with the conventional graphic recorder. The Digital Reader converts the deflection voltage into a binary code represented by closure of circuits. These may be made to operate a Key Punch which punches into a single column of a standard card the record of the voltage in binary digital form. The data can then be processed by standard punched-card equipment. Examples of various kinds of spectra recorded in digital form on punched cards are presented, together with some examples of processed data. A.

535.33.03 : 536.46

7266. Flame zone spectroscopy of solid propellants. R. G. REKERS AND D. S. VILLARS. *Rev. sci. Instrum.*, **25**, 424–9 (*May*, 1954).

The spectroscopy of burning solid propellants has been generally limited to a photographic integration of the various flame zones as the burning strand is consumed and the flame passes a spectrographic slit. A few instances have been reported in which separation of the spectral emission from the different zones of the flame has been attempted, but the results are deficient either through loss of resolution of the spectrograph system or shortness of exposure time. An automatic constant level device is reported which now permits the isolation and detailed exposure of a definite flame zone throughout the complete time of burning of a 72 in. length of strand. A discussion of the technique, illustrated with typical data on the degree of control, is presented. Typical absorption and emission spectrograms are given. A.

535.33.03 : 537.523.4

7267. The afterglow spectrum of long sparks in air. A. VASSY. *C.R. Acad. Sci.* [*Paris*] **238**, 1398–1400 (*March* 29, 1954) *In French.*

Gives results obtained with time-resolved spectroscopy of 500–900 kV sparks, and lists various observed levels and bands. J. D. CRAGGS

535.33.07

7268. Direct-reading metal spectroscopy with a d.c. arc. S. C. BAKER. *Brit. J. appl. Phys.*, **5**, 215–19 (*June*, 1954).

A d.c. globule arc that hisses vigorously has been developed in conjunction with a direct-reading spectrometer built on a wavelength spectrometer and measuring intensity ratios by the null indication of a symmetrical cathode-follower bridge circuit. Self-electrodes are held in massive brass supports with the anode uppermost and the arc run until large molten globules form and stabilize on both electrodes. The relationship between the manganese concentration in carbon steels and the intensity ratio of manganese 4754 Å to iron 5455·6 Å is linear in the range 0·3% to 1·3% manganese and standard deviations of 2% of content have been obtained. Standard deviations of 4% have been obtained by ordinary photographic photometry using manganese 4754 Å and iron 4707·281 Å. A method of preparing a working curve from a knowledge of the background intensity of the manganese line and a single standard sample is suggested. There is a discontinuity in the volt-ampere characteristic of the arc but the curve is nearly parallel to the current axis at the operating point. A.

535.33.07 : 535.372

7269. Spectrophotometry of fluorescent pigments. R. DONALDSON. *Brit. J. appl. Phys.*, **5**, 210–14 (*June*, 1954).

A method is described for measuring the spectral reflection of fluorescent pigments for incident monochromatic light covering the ultraviolet and visible regions of the spectrum. The results are recorded in the form of a square table from which quantum

efficiencies and spectral reflection curves for sunlight or any illuminant of known energy distribution are calculated. Data are given for a red pigment and an optical bleach. Three curves only, showing the variation of tristimulus values with incident wavelength, are sufficient for the calculation of colour. The curves of tristimulus values may be derived from the reflection curves or measured directly by a template colorimeter. A.

535.33.07 : 539.132

7270. Limitation to the precision of molecular constants determined with a diffraction grating. D. H. RANK. Letter in *J. Opt. Soc. Amer.*, **44**, 341 (*April*, 1954).

Ruling errors lead to uncertainties in wavelength determinations of ~ 1 in 10^6, which result in an uncertainty of $\sim 1 \times 10^{-4}$ in B values. G. F. LOTHIAN

535.33.07 : 771.534

7271. Effect of stray light in prism and grating spectrographs on emulsion calibration curves and its significance in spectrographic analysis. R. N. KNISELEY AND V. A. FASSEL. *J. Opt. Soc. Amer.*, **44**, 390–3 (*May*, 1954).

Several investigators have observed that emulsion calibration curves obtained from spectrograms exposed in Littrow mounting prism spectrographs exhibit a smaller slope than the corresponding curves obtained from spectrograms exposed in Wadsworth mounting grating spectrographs. A study of the nature of this difference has shown that stray light originating from direct reflection and lens flare at the collimating-camera lens in the Littrow prism spectrograph is responsible. Since the magnitude of the integrated stray light radiation falling on any area of the emulsion is dependent on the number and proximity of exposures, the slope of the emulsion calibration curves obtained from Littrow spectrograph exposures may change with placement on the plate, unless focal-plane diaphragming is employed. The significance of this stray light factor in spectrographic analysis and in relative intensity measurements is discussed. A.

535.33.07–14 : 539.132

7272. Microwave spectroscopy. M. W. P. STRANDBERG. *London: Methuen and Co.; New York: John Wiley and Sons*, vii + 140 *pp*.

Review in *Brit. J. appl. Phys.*, **5**, 229 (*June*, 1954). "The purpose of this book is to make available such information as is required to obtain and to interpret microwave spectroscopic data as far as they refer to rotating molecules."

535.33.07–14 : 621.317.761.029.6

7273. A precision frequency-measuring system for microwave spectroscopy. I. TAKAHASHI, A. OKAYA AND T. OGAWA. *J. Inst. Elect. Commun. Engrs Japan*, **35**, 462–5 (*Oct.*, 1952) *In Japanese*.

The frequency of a 100 kc/s crystal oscillator, checked by standard transmissions from station JJY, is multiplied in a valve circuit and cross-modulated with a frequency of 24 Mc/s to generate a frequency of 432 Mc/s together with sideband frequencies. Further multiplication by means of a crystal multiplier brings the frequencies into the 9 kMc/s region, with marker frequencies at intervals of 24 Mc/s which are used to produce pips on the screen of a c.r.o. A selected pip is superposed on an absorption line by adjusting the frequency of an interpolation receiver. The estimated maximum measurement error of 8 kc/s in the 9 kMc/s range was confirmed by observations on several ammonia absorption lines. A. WILKINSON (R)

535.33.088

7274. The frequency distribution of the spectrographic (d.c. arc) error. A. C. OERTEL AND E. A. CORNISH. *Austral. J. appl. Sci.*, **4**, 489–507 (*Dec.*, 1953).

A sample of 1161 errors, derived from 259 sets of triplicate and 64 sets of sextuplicate measurements of line intensity, has been used to determine the frequency distribution of the spectrographic error which occurs in the d.c. arc excitation of samples of soil and plant ash. It has been found that the error is, in the greater part at least, a proportional one, and when expressed on a logarithmic scale, its frequency distribution, so far as can be ascertained from these data, is normal. It follows that measures and tests of significance based upon the hypothesis of normality are applicable in spectrographic (d.c. arc) investigations. Additional data are being accumulated to provide the means for making more comprehensive tests of the nature of the frequency distribution. A.

535.337

7275. Effects of inert atmospheres on emission spectra in the interrupted arc. H. STONE. *J. Opt. Soc. Amer.*, **44**, 411–13 (*May*, 1954).

A comparison of the spectra of several elements produced in the interrupted arc in helium, helium-oxygen mixtures, argon, and air has been made. It has been found that the differences observed in the spectra are not uniform, but vary according to the ionization states of the spectral lines; those lines requiring large energies for excitation being more intense in a rare gas atmosphere than in air, and those lines requiring small energies for excitation being more intense in air than in a rare gas. It is shown that with the interrupted arc the use of rare gas atmospheres cannot lead, except in isolated cases, to an improvement in the sensitivity of emission spectrographic analysis. A.

535.337

7276. Pressure shift in helium λ5875. J. R. HOLMES AND L. PAPE. *Phys. Rev.*, **94**, 902–3 (*May* 15, 1954).

Using a Fabry–Perot interferometer, pressure shift in λ5875 ($2^3P - 3^3D$) of He^4 was looked for over a pressure range from 5×10^{-2} to 20 mm. A mean shift of $0{\cdot}0074\ cm^{-1}$ toward lower frequency at the higher pressure was found. As this is within the experimental error, it is concluded that over the above pressure range, pressure shift is not likely to falsify isotope shift measurements in the helium spectrum significantly. A.

535.337 : 537.228.5

7277. Stark effect on the $6\ ^3P_1$ level of the mercury atom. J.-E. BLAMONT AND J. BROSSEL. *C.R. Acad. Sci.* [*Paris*] **238**, 1487–9 (*April* 5, 1954) *In French*.

When Hg atoms in a magnetic field H_0 of ~ 63 gauss are excited by 2537 Å radiation polarized with its electric vector || to H_0, normally only the π component ($m = 0$) of the triplet is excited and the re-emitted

radiation is plane polarized. But if radiation of 138·6 Mc/s is present, $m_0 \rightarrow \pm 1$ transitions occur in the excited state and the σ components appear in emission and may be used to detect the resonance by plotting the intensity of the σ radiation against H_0. With a Stark field of 60 000 V/cm the $m_0 \rightarrow +1$ and $m_0 \rightarrow -1$ transitions are separated by ~3·5 Mc/s and the graph against H_0 now shows two resonance peaks, at a fixed frequency of 138·6 Mc/s. D. H. WHIFFEN

535.338.1

7278. Intensity measurements in the arc spectrum of nickel. R. L. HEID AND G. H. DIEKE. *J. Opt. Soc. Amer.*, **44**, 402–10 (*May*, 1954).

The relative intensities of 478 nickel arc lines have been measured photoelectrically between 3359 and 5893 Å with an accuracy of better than 1% for the good lines. The d.c. arc was operated under steady conditions at a current of 2 A. Corrections for self-absorption have been determined. The influence of arc fluctuations has been minimized by recording always the ratio of the output of a scanning tube to that of a fixed tube placed on a control line. A.

535.338.3

7279. An unusual duplication of spectral lines. J. JUNKES AND E. W. SALPETER. Note in *Naturwissenschaften*, **41**, *No.* 7, 160 (1954) *In German.*

On spectrograms of an h.f. interrupted-arc source made with a conventional 3-prism spectrograph and auto-collimation camera (130 cm focus) the lines appeared double. The cause was traced to a mechanical vibration of the prism-mounting in phase with the frequency of interrupted-current supply to the arc, and of amplitude ~3″ of arc. D. R. BARBER

535.338.3

7280. Furnace spectrum of plutonium. J. G. CONWAY. *J. Opt. Soc. Amer.*, **44**, 276–8 (*April*, 1954)

The spectrum was observed over the temperature range of 2000° to 2600°C and a wavelength coverage of 3476 to 6888 Å. The spectrum was excited in a modified King furnace. A.

535.338.3

7281. The ultra-violet emission spectra of the gaseous monofluorides of gallium and indium. R. F. BARROW, J. A. T. JACQUEST AND E. W. THOMPSON. *Proc. Phys. Soc.* [*London*] *A*, **67**, 528–32 (*June*, 1954).

The emission spectra of GaF and InF may be excited conveniently in hot hollow-cathode tubes, the cathode containing a mixture of the respective metal with aluminium trifluoride. The emission spectra are similar to those observed in absorption, but many more bands of the $^3\Pi$–$^1\Sigma$ systems of InF have been observed. The Ga isotope effect in GaF has been resolved, and improved constants are derived for the two molecules. A.

535.338.32

7282. Magnetic rotation of the plane of polarization of broadened resonance lines. A. JABŁOŃSKI. *Acta phys. Polon.*, **13**, *No.* 2, 91–4 (1954).

According to Weisskopf's theory of resonance fluorescence the rotation of the plane of polarization of resonance radiation by weak magnetic fields is not the same throughout the whole breadth of the line, as one should expect on the ground of a semi-classical explanation of the effect given by Hanle, but depends on frequency. Weisskopf's equation, valid for the case of resonance lines not broadened by pressure and/or by Doppler effect, giving the dependence of the angle of rotation on frequency is generalized so as to include also the case of broadened lines. A.

535.338.32

7283. Quenching of mercury resonance radiation. IV. Unsaturated compounds. B. DEB. DARWENT, M. K. PHIBBS AND F. G. HURTUBISE. *J. chem. Phys.*, **22**, 859–62 (*May*, 1954).

For Pt III, see Abstr. 3284 (1954). The cross-sections for quenching mercury resonance radiation by a number of mono- and di-olefins, acetylenes, substituted olefins, and other compounds containing multiply bonded atoms have been measured. The quenching cross-sections of mono-olefins increase with increasing molecular weight but not with increased branching of the carbon skeleton. The position of the double bond has little or no effect on the cross-section. The substitution of fluorine for hydrogen decreases the cross-section of olefins. The presence of a second double bond does not alter the cross-section. The double bond is more effective when between two carbon atoms than when it is between two nitrogens or carbon and oxygen. The cross-sections of acetylenes are essentially the same as those of the corresponding olefins but here the substitution of N for CH does not appear to alter the effective cross-section. A.

535.338.332

7284. Hyperfine structures in the atomic spectrum of calcium. F. M. KELLY, H. KUHN AND A. PERY. *Proc. Phys. Soc.* [*London*] *A*, **67**, 450–6 (*May*, 1954).

The spectrum of calcium was excited in a hollow cathode tube cooled with liquid hydrogen. The use of a sample of calcium enriched in the isotope 43 allowed hyperfine structures to be resolved in the arc line λ6103 ($4s4p\ ^3P_0$–$4s5s\ ^3S_1$) and the spark lines λ3933 ($4s\ ^2S_{1/2}$–$4p\ ^2P_{3/2}$) and λ3968 ($4s\ ^2S_{1/2}$–$4p\ ^2P_{1/2}$), from which an approximate value of −1·2 nuclear moments (n.m.) for the nuclear magnetic moment was derived. The intensity ratio of the components of the arc line was found to be affected by self-absorption due to the metastability of the lower term. After correction for this effect, the measured intensity ratio agreed best with a value of 7/2 for the nuclear spin. After publication of the value of the gyromagnetic ratio by Jeffries [Abstr. 7039 (1953)], the measurements of the width of splitting of the spark lines allowed the nuclear spin to be determined conclusively as $I = 7/2$, in agreement with the predictions from the shell model and the value deduced from the strength of the nuclear resonance signal. The splitting of the ground term, $0{\cdot}109 \pm 0{\cdot}002\ cm^{-1}$, is 4% smaller than the value calculated from the gyromagnetic ratio by the use of the formulae of Goudsmit, Fermi, Segrè, Breit and Racah. A.

535.338.332

7285. The hyperfine structure of the $3P_{3/2}$ state of Na^{23}. P. L. SAGALYN. *Phys. Rev.*, **94**, 885–92 (*May* 15, 1954).

Two of the separations in the hyperfine structure of the $3P_{3/2}$ state of Na^{23} were measured. The results are

61 ± 2 Mc/s and 36·6 ± 2 Mc/s. These results were assigned to the ($F=3\leftrightarrow F=2$) and ($F=2\leftrightarrow F=1$) separations. A value of $Q = +0{\cdot}1 \pm 0{\cdot}06\times10^{-24}$ cm^2 was calculated for the nuclear electric quadrupole moment. A.

535.338.332 : 539.152.2

Nuclear spin of Am^{243} and isotope shift in americium spectrum. *See Abstr.* 7654

535.338.334

7286. Stark-effect broadening of Balmer lines at high electron densities. H. Griem. *Z. Phys.*, **137**, *No.* 3, 280–94 (1954) *In German.*

Describes an experimental arrangement for the observation of Stark-broadened hydrogen lines in arc discharges. The detailed theoretical discussion and the experimental data relate in particular to two aspects, namely the asymmetry of Hβ at high electron and ion densities and the contribution made by the electrons to the line broadening. See also abstract following. J. D. CRAGGS

535.338.334

7287. On the Stark-effect broadening of the higher Balmer lines. W.-D. Henkel. *Z. Phys.*, **137**, *No.* 3, 295–308 (1954) *In German.*

Describes measurements made on Stark-widened lines, i.e. the inhomogeneous field effect encountered in discharge plasmas for impulsive discharges, with currents varying from 50 to 200 A. Observations were made on five members of the Balmer series, beginning with Hβ. From considerations of the broadenings it is possible to assess the perturbing effect of electrons, as well as that of the positive ions. A full theoretical discussion is given. See also preceding abstract. J. D. CRAGGS

535.338.4

7288. Ultra-violet and blue bands of calcium oxide. A. Lagerqvist. *Ark. Fys.*, **8**, *Paper* 6, 83–95 (1954).

Two band systems of CaO, consisting of a $^1\Pi$–$^1\Sigma$ system in the blue and violet part of the spectrum and a $^1\Sigma$–$^1\Sigma$ system in the ultraviolet, here designated $B\rightarrow X$ and $C\rightarrow X$ respectively, have been made the object of a rotational analysis. The following bands have been examined: in $B\,^1\Pi$–$X\,^1\Sigma$: 0·2, 0·1, 1·0 and 1·3; in $C\,^1\Sigma$–$X\,^1\Sigma$: 0·3, 0·2, 1·0, 1·4, 2·0 and 3·0. The common lower state is already known. In the upper states several perturbations have been found. It is difficult to predict anything about the nature of the perturbing states. From the appearance of some perturbations in the $B^1\,\Pi$ state it is not out of the question that the interacting state is a $^3\Sigma$ state. Supposing $X\,^1\Sigma$ to be a $^1\Sigma^+$ state, then this perturbing state is a $^3\Sigma^+$. A.

535.338.4

7289. On the so-called "blue bands of benzaldehyde." S. N. Garg. *J. sci. industr. Res.*, **13 B**, 155–9 (*March*, 1954).

It is suggested that the "blue bands" are due to the radical, C_6H_5C, common to all the compounds in which these bands are known to occur. The strong and prominent frequency 1,730 cm^{-1}, previously supposed to be a carbonyl frequency, it is suggested, may be due to the vibration of C against C_6H_5 with a bond strength of more than one in the radical. The few weaker, sharp and single-headed additional bands observed may be due to toluene itself. These have been analysed separately from the above bands. A general correlation of frequencies with those of benzene is given. A.

535.338.4

7290. Is there a spectrum of the OH^- ion? H. Schüler, L. Reinebeck and A. Michel. *Z. Naturforsch.*, **9a**, 279–85 (*April*, 1954) *In German.*

The conditions of excitation of a spectrum excited in water vapour have been studied, and it is concluded that the emitter is OH^-. A number of bands in the region 18 000 to 24 000 cm^{-1} have been observed both from H_2O and from D_2O: they consist of single *P* and *R* branches, and rotational analyses of six bands have been performed. It has not yet proved possible to assign absolute values of v', v''. R. F. BARROW

535.338.4

7291. Emission spectra of the molecules Cu_2, Ag_2 and Au_2. J. Ruamps. *C.R. Acad. Sci.* [*Paris*] **238**, 1489–91 (*April* 5, 1954) *In French.*

A number of emission bands have been observed in a King furnace. Preliminary values of the constants (cm^{-1}) are as follows:

System	$\nu_{0,0}$	ω	ω_0''
Cu_2 A	20 402	193	263
Cu_2 B	21 750	240	264
Ag_2 B	22 984	153	190
Au_2 A	19 650	145	188
Au_2 B	25 690	177	189

The assignments to Cu_2 and Ag_2 are confirmed by the vibrational isotope effect. R. F. BARROW

535.338.4–31

7292. On the u.v. emission spectrum of toluene. Emission observed from vibrational levels in the upper electronic state to vibrationless ground state. S. N. Garg. *J. sci. industr. Res.*, **13 B**, 151–5 (*March*, 1954).

Employing the modified discharge tube arrangement, the emission spectrum of toluene has been observed to ~ 1850 cm^{-1} on the shorter wave side of the origin. This consists of sharp bands in the positions mostly expected from the corresponding absorption spectrum. A revised analysis of the absorption spectrum of toluene is proposed and a correlation of frequencies with those of benzene has been made. A.

535.343

7293. Spectral anomalies produced by the overlapping of absorption bands. J. M. Vandenbelt and C. Henrich. *Appl. Spectrosc.*, **7**, 171–6 (*Nov.*, 1953).

An attempt is made to investigate the effects of overlapping between bands in spectra, especially the apparent wavelength change by combinations. Pairs of symmetrical band outlines are plotted, the two components having various intervals of separation and relative intensities. Empirically, spectra can be approximated by such addition of component bands. The two components are then summed. It is found that overlapping may cause apparent shift in position with a small (or large) band, when overlaid with a large (or small) one. Broad bands rather than

narrow may appear to be away from their true position. No rule could be found for the proper selection of partially obscured bands. A. J. TAYLOR

535.343

7294. Splitting of electronic levels in the absorption spectrum of erbium and thulium in complex salts. L. HOLLECK AND D. ECKARDT. *Z. Naturforsch.*, **9a**, 347–8 (*April*); Erratum, 476 (*May*, 1954) *In German.*

It is shown that Er is analogous to Nd and Tm to Pr in the way they react to internal electrical fields. This suggests a maximum influence of internal fields in the middle of the rare earth group. C. TURNER

535.343 : 539.132

7295. The electronic absorption spectrum and the molecular vibrations of thiophosgene. J. DUCHESNE. *J. Phys. Radium*, **15**, 211–12 (*March*, 1954) *In French.*

Previously recorded data on the absorption spectrum of $CSCl_2$ in the range 2600 to 5700 Å are analysed. G. I. W. LLEWELYN

535.343.1 : 541.126

7296. Absorption spectroscopy of explosions. P. L. HANST AND A. L. MYERSON. *Rev. sci. Instrum.*, **25**, 469–70 (*May*, 1954).

The Norrish–Porter flash technique of ultraviolet spectroscopy has been adapted to the study of explosions induced by the thermal energy of the reacting gases at the temperature of mixing. The light emitted by the reacting gases during the induction period is used to actuate the flash source by means of a phototube and its associated electronic circuit. The concentrations of free radicals and other short-lived molecular species can be studied as a function of time. A.

535.343.2–15

7297. The infrared spectrum of crystalline nitrogen pentoxide. R. TERANISHI AND J. C. DECIUS. *J. chem. Phys.*, **22**, 896–900 (*May*, 1954).

The infrared absorptions of thin films of crystalline $N_2^{14}O_5$ and $N_2^{15}O_5$ maintained at liquid nitrogen temperature have been investigated between 4 and 20 microns. The spectrum is readily interpreted on the basis of the $NO_2^+NO_3^-$ structure previously indicated by Raman and X-ray data. All the constants of the most general quadratic potential functions for the two ions have been evaluated, and the relatively large errors in these constants and their significance in relation to the electronic structure is discussed. A.

535.343.3–31

7298. Isotope effect in continuous ultraviolet absorption spectra: methyl bromide-d_3 and chloroform-d. A. A. GORDUS AND R. B. BERNSTEIN. *J. chem. Phys.*, **22**, 790–5 (*May*, 1954).

A comparison of the continuous ultraviolet absorption spectra of CH_3Br and CD_3Br indicated a nearly constant shift of $+280 \pm 50\ cm^{-1}$ upon deuterium substitution. In the case of $CHCl_3$ and $CDCl_3$ the shift was less than the uncertainty of $\pm 50\ cm^{-1}$. These results are interpreted in terms of the Herzberg–Goodeve picture involving the carbon–halogen bond rupture. The ultraviolet absorption spectra of CCl_4, $CFCl_3$, CH_2Cl_2, CF_2Cl_2, and $CHFCl_2$ are also reported. A.

535.343.32/.4

7299. Investigation of the spectra of substituted phthalimides in vapour and in solution. B. S. NEPORENT, V. V. ZELINSKIĬ AND V. P. KLOCHKOV. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 5, 927–30 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-216.*

535.343.32–15

7300. Infrared absorption spectra of aqueous HF_2^-, DF_2^-, and HF. L. H. JONES AND R. A. PENNEMAN. *J. chem. Phys.*, **22**, 781–2 (*May*, 1954).

Strong infrared absorption bands of KHF_2 appear at 1233 cm^{-1} and 1473 cm^{-1} in the solid, and are observed at 1206 cm^{-1} and 1536 cm^{-1} respectively, in H_2O solution. Corresponding values for KDF_2 are 888 cm^{-1} and 1045 cm^{-1} in the solid, and 873 cm^{-1} and 1102 cm^{-1} in D_2O solution. In saturated KHF_2 and in KHF_2 solutions containing excess HF, there appear new, broad absorption bands attributed to polymeric species, e.g. $H_2F_3^-$. The HF_2^- ion is observed in concentrated aqueous HF; in addition, there is a strong absorption at 1820 cm^{-1} which is not shifted in D_2O–HF mixtures. A.

535.343.4

7301. Experimental study of the perturbation of the 2537 Å line of mercury by hydrogen and helium compressed up to 1450 kg/cm². J. ROBIN. *C.R. Acad. Sci.* [*Paris*] **238**, 1491–3 (*April* 5, 1954) *In French.*

In absorption the line is displaced towards higher frequency by He and a satellite band appears around 2520 Å. With H_2 a change in the direction of displacement occurs with increasing pressure. In both cases the line remains practically symmetrical despite the large broadening. A. G. GAYDON

535.343.4–14

7302. Microwave spectrum of cyclopentanone. G. ERLANDSSON. Letter in *J. chem. Phys.*, **22**, 563–4 (*March*, 1954).

535.343.4–14

7303. Hyperfine structure in the spectrum of $N^{14}H_3$. I. Experimental results. G. R. GUNTHER-MOHR, R. L. WHITE, A. L. SCHAWLOW, W. E. GOOD AND D. K. COLES. *Phys. Rev.*, **94**, 1184–91 (*June* 1, 1954).

The structure of the hyperfine spectrum of $N^{14}H_3$ in the microwave region has been carefully re-examined. It has been found that the N^{14} quadrupole line spacings for $K \neq 1$ can be fitted within experimental error to previously developed theory, provided a small change in the quadrupole coupling constant eqQ due to centrifugal distortion of the molecule is allowed for. For $K = 1$; and $J = 2,3,4$, a doubling of each line of the quadrupole pattern has been found which increases from about 70 to 150 kc/s with increasing J. It has been possible to explain these new features of the spectrum in terms of the interactions of the magnetic moments of the protons with the molecular magnetic field caused by rotation and with the magnetic moment of the N^{14} nucleus. A.

535.343.4–14

7304. Hyperfine structure in the spectrum of $N^{14}H_3$. II. Theoretical discussion. G. R. GUNTHER-MOHR, C. H. TOWNES AND J. H. VAN VLECK. *Phys. Rev.*, **94**, 1191–203 (*June* 1, 1954).

The new features in the hyperfine spectrum of

$N^{14}H_3$ described in Pt I are shown to be due to the interactions of the magnetic moments of the three protons with the molecular magnetic field caused by rotation and with the magnetic moment of the N^{14} nucleus. Since the protons are off the molecular symmetry axis, these interactions are of a form different from that usually encountered. They possess matrix elements connecting states differing by two units in symmetric top quantum number K and are capable, therefore, of lifting the degeneracy between states for which $K = -1$ and $K = 1$. A systematic treatment of the problem of the hyperfine interactions in this molecule has been made in order to find any other effects detectable with present equipment. A.

535.343.4–14 : 539.133

7305. The microwave spectrum and structure of chlorofluoromethane. N. MULLER. *J. Amer. Chem. Soc.*, **75**, 860–3 (*Feb.* 20, 1953).

The microwave spectra of $CH_2Cl^{35}F$ and $CH_2Cl^{37}F$ between 16 100 and 39 000 Mc/s have been measured and analysed. The rotational parameters are $a = 41\,810{\cdot}1$ Mc/s, $b = 5715{\cdot}7$ Mc/s, $c = 5194{\cdot}6$ Mc/s, and $a = 41\,738{\cdot}2$ Mc/s, $b = 5580{\cdot}5$ Mc/s, $c = 5081{\cdot}6$ Mc/s, respectively. The structural parameters, calculated with an assumed value of 111° 56′ for the H–C–H angle, are $r_{CH} = 1{\cdot}078 \pm 0{\cdot}005$ Å, $r_{CCl} = 1{\cdot}759 \pm 0{\cdot}003$ Å, $r_{CF} = 1{\cdot}378 \pm 0{\cdot}006$ Å. Cl–C–F = 110° 1′ ± 2′, $\theta = 125°\,41' \pm 5'$, where θ is the angle between the C–Cl bond and the projection of the C–H bonds on the symmetry plane. From the hyperfine structure of the $1_{0,1}$–$1_{1,0}$ transition, the quadrupole coupling constants were evaluated as $\chi_a = -52{\cdot}18 \pm 1$ Mc/s, $\chi_b = 38{\cdot}83 \pm 1$ Mc/s. With certain assumptions, this leads to a value of 6·6% for the per cent double-bond character of the C–Cl bond. A.

535.343.4–14 : 539.133

7306. Microwave spectrum and dipole moment of pyridine. B. B. DEMORE, W. S. WILCOX AND J. H. GOLDSTEIN. *J. chem. Phys.*, **22**, 876–7 (*May*, 1954).

The microwave spectrum has been studied in the region from 20 000 to 40 000 Mc/s. Twelve low-J R-branch lines have been identified. Analysis of the spectrum requires that the dipole moment lie in the a axis, and leads to the following values of rotational constants: $a = 6039{\cdot}436$ Mc/s, $b = 5804{\cdot}997$ Mc/s, $c = 2959{\cdot}210$ Mc/s and $\kappa = +0{\cdot}847781$. The dipole moment of pyridine vapour was found to be $2{\cdot}15 \pm 0{\cdot}05$ D from quantitative Stark effect studies. A.

535.343.4–15

7307. Infrared spectrum of hydrogen sulfide in the 6290-cm^{-1} region. H. C. ALLEN, JR AND E. K. PLYLER. *J. Res. Nat. Bur. Stand.*, **52**, 205–10 (*April*, 1954).

The absorption in the region 6100 to 6500 cm^{-1} has been measured under high resolution. The rotational fine structure has been analysed through the use of published energy tables for the rigid rotor. A classical centrifugal-distortion correction was applied to the rigid energy levels. It is found that there are two overlapping bands in this region, a normally strong, A-type band, the $(n_1, n_2, n_3) = (1, 1, 1)$, and a normally weak, B-type band, which becomes strong enough to be observed by borrowing intensity from the A-type band through a Coriolis interaction. The B-type band is the lower component of the resonating pair (2, 1, 0) and (0, 1, 2). The excited state inertial parameters giving the best fits are (1, 1, 1) band, $A = 10{\cdot}398$, $B = 8{\cdot}935$, $C = 4{\cdot}548$, $\mu_0 = 6289{\cdot}26$ cm^{-1}; (0, 1, 2) band, $A = 10{\cdot}394$, $B = 8{\cdot}918$, $C = 4{\cdot}547$, $\mu_0 = 6288{\cdot}28$ cm^{-1}. A.

535.343.4–15

7308. The infrared spectrum of disilane. H. S. GUTOWSKY AND E. O. STEJSKAL. *J. chem. Phys.*, **22**, 939–43 (*May*, 1954).

The infrared absorption spectrum of Si_2H_6 gas has been observed from 350 to 4000 cm^{-1}. Four of the five infrared active fundamentals have been found and assigned (ν_5 and ν_6, $\parallel$ bands at 2154·4 and 842·7 cm^{-1}; ν_7 and ν_8, $\perp$ bands at 2181·1 and 945·7 cm^{-1}). The Q branches of ν_7 and ν_8 were observed with moderate dispersion and the spacings measured as $2{\cdot}43_5$ and $3{\cdot}42$ cm^{-1}. These spacings are consistent with the Coriolis interaction in a symmetric top without internal rotation, but they do not agree with the spacings predicted by assuming free internal rotation. The general appearance of ν_7 and ν_8 in disilane is similar to these bands in ethane, suggesting comparable potential barriers to internal rotation. In the course of the experiments it was found that disilane decomposes slowly at room temperature into SiH_4 and that in the preparation of disilane from Si_2Cl_6, the Si — Si bond is cleaved by an excess of $LiAlH_4$, producing SiH_4. A.

535.343.4–15 : 539.132

7309. Infrared spectrum of $S^{16}O^{18}O$ and the potential constants of SO_2. S. R. POLO AND M. K. WILSON. *J. chem Phys.*, **22**, 900–3 (*May*, 1954).

An investigation of the infrared spectrum of $SO^{16}O^{18}$ results in the following frequency assignment. $\nu_1 = 1122 \pm 1$ cm^{-1}, $\nu_2 = 506{\cdot}8 \pm 0{\cdot}5$ cm^{-1}, $\nu_3 = 1341 \pm 0{\cdot}5$ cm^{-1}. These data combined with the fundamental frequencies of SO_2^{16} have been used to calculate the potential constants for sulphur dioxide. These are $f_d = 10{\cdot}02$, $f_{dd} = 0{\cdot}03$, $(1/d)f_{d\alpha} = 0{\cdot}20$, $(1/d^2)f_\alpha = 0{\cdot}793$. A.

535.343.4–31

7310. Analysis of the near ultraviolet absorption spectrum of acetylene. K. K. INNES. *J. chem. Phys.*, **22**, 863–76 (*May*, 1954).

The absorption spectrum of acetylene in the region 1970–2470 Å has been photographed in the fourth and fifth orders of a twenty-one-foot grating spectrograph with absorbing paths of 0·007 to 70 m-atmos. It has been possible to extend the arguments which led King and Ingold to conclude that in the upper electronic state the molecule is bent and has C_{2h} symmetry. The upper electronic state is A_u or, possibly A_g. The effective moment of inertia I_a of the excited state is small, causing sub-band separations of 50 to 150 cm^{-1}. These sub-bands all have P, Q and R branches, are well-resolved, and have the appearance of bands of diatomic molecules. The following rotational constants of the upper state are derived: $A_0 = 12{\cdot}94$, $B_0 = 1{\cdot}1247$, $C_0 = 1{\cdot}0297$ cm^{-1}. If the C — H distance is assumed to be between 1·070 and 1·090 Å, one finds $r_{CC} = 1{\cdot}38_8$ Å, $\angle CCH = 120°$.

Ground-state combination differences are in agreement with precise values derived from infrared data. Some new lower state B values are obtained. The $O - O$ vibrational transition is shown to be at 42 197·69 cm^{-1}. The sub-bands form v_4'' progressions and v_3' progressions. Analysis gives two upper state vibrational frequencies: $\nu_3(CCH) = 1047{\cdot}70$ cm^{-1} and $\nu_2(CC) = 1389$ cm^{-1}. The following lower state vibrational constants are obtained: $\omega_4^0 = 608{\cdot}2_6$, $x_{44} = +3{\cdot}29$, $g_{44} = +0{\cdot}1_7$ cm^{-1}. The fundamental frequency v_4'' is the sum of these constants, that is $611{\cdot}7_2$ cm^{-1}. A.

535.345

7311. The optical constants of silver, gold, copper, and aluminium. I. The absorption coefficient k. L. G. SCHULZ. *J. Opt. Soc. Amer.*, **44**, 357–62 (*May*, 1954).

A description is given of a comparison method for determining the values of the absorption coefficient k of a metal relative to previously determined values for Ag. In this method transmission interference filters are constructed which have mica as the dielectric and have reflecting layers of Ag and of the metal x being studied. On adjacent areas of a single sheet of mica, pairs of filters are formed, one with a Ag-mica-Ag combination and the other with a Ag-mica-x combination. Components of a filter pair will have identical mica thicknesses. For a given filter pair the wavelengths transmitted by one combination are compared with those transmitted by the other. Values of k are then calculated from the change in phase accompanying the reflection of light at normal incidence at mica-metal interfaces. The method was found to have special advantages in the wavelength region of 0·65 μ to 0·95 μ for metals with high reflectivities. Results are given for Au, Cu and Al in the range of 0·45 μ to 0·95 μ. The new values of k tend to be higher than older values obtained by other methods. A discussion is included concerning the validity of surface measurements for determining the bulk properties of metals. [For Pt II, see Abstr. 7263 (1954).] A.

535.345

7312. Optical absorption of single-crystal strontium titanate. J. A. NOLAND. Letter in *Phys. Rev.*, **94**, 724 (*May* 1, 1954).

The absorption coefficient of crystals prepared by the flame fusion technique was measured from 0·35 to 15·0 μ. The ultraviolet cutoff at 0·385 μ is associated with the energy-gap between valence and conduction bands. High transmission was found between 0·55 and 5·0 μ. Absorption bands at 5·5 and 7·5 μ are probably due to crystal vibrations. The absorption found by Linz [Abstr. 8389 (1953)] at 2·0 μ was not observed. A. J. TAYLOR

535.345 : 532.77

7313. Theory of the absorption, dispersion and scattering of light by solutions. A. S. DAVÝDOV. *Zh. eksper. teor. Fiz.*, **24**, *No.* 2, 197–209 (1953) *In Russian.*

A mathematical analysis is carried out of the effect of the solvent on the molecular absorption, scattering and dispersion spectra, no detailed assumptions being made with regard to the solvent model. The analysis begins with the discussion of the energy states of a solution, and of the interaction between the light and solution. Formulae are developed for calculating the coefficients of absorption, dispersion and probability of scattering of light by the molecule of the admixture; other formulae are developed for the temperature dependence of these coefficients and for other parameters characteristic of oscillations of the solvent atoms and their interaction with the molecules of the solute in different states of energy. F. LACHMAN

535.345 : 535.371

7314. Absorption and fluorescence of crystal violet, methyl violet and malachite green. E. LAFFITTE AND Y. DUBREUIL. *C.R. Acad. Sci.* [*Paris*] **238**, 787–9 (*Feb.* 15, 1954) *In French.*

535.345–15 : 539.11

7315. Infrared properties of metals and the mean free paths of conduction electrons. J. EULER. *Z. Phys.*, **137**, *No.* 3, 318–32 (1954) *In German.*

The infrared transmission of thin films of metal does not always follow the theoretical curve derived by earlier workers. Electron microscopy shows the films often consist of discrete particles. Euler calculates the properties of flat ellipsoids of dimensions less than a mean free path, and shows that the curves can be explained if the particles start as spheres, and then, as more metal is deposited, become progressively larger and flatter ellipsoids before joining up into the continuous sheet usually assumed. W. M. LOMER

535.345–32 : 535.371

7316. Some optical properties of MgO in the vacuum ultraviolet. P. D. JOHNSON. *Phys. Rev.*, **94**, 845–6 (*May* 15, 1954).

The optical absorption and the excitation spectrum for luminescence of synthetic periclase crystals have been determined in the vacuum ultraviolet. From these measurements it is deduced that the width of the forbidden energy band of MgO is approximately 7·4 eV. A.

535.345–32

7317. Absorption coefficients of air and nitrogen for the extreme ultraviolet. J. P. CURTIS. *Phys. Rev.*, **94**, 908–10 (*May* 15, 1954).

A method involving the use of two photomultiplier tubes as detectors has been developed for absorption studies in the extreme ultraviolet. The monochromator was a modified grazing-incidence spectrograph. A capillary discharge tube was employed as a source. Absorption coefficients for dry air and nitrogen were measured in the range 150 Å–1000 Å. The total oscillator strength of nitrogen for the transitions appropriate for this range was computed to be 3·2. A.

535.345.6

7318. A filter transmitting near the mercury line, 2537 Å. K. OSADA. *J. Phys. Soc. Japan*, **9**, 136–7 (*Jan.–Feb.*, 1954).

Starch-iodine adsorbed on a gelatine film transmits in the region 2440–2560 Å and also in the red and infrared. G. F. LOTHIAN

535.361.2–15

7319. Study of the diffuse reflection factor of silico-aluminous refractories in the infrared at high temperatures. R. ALÈGRE. *C.R. Acad. Sci.* [*Paris*] **238**, 1209–10 (*March* 15, 1954) *In French.*

Reflection measurements are made with a chopped

beam (to eliminate the effects of radiation from the hot specimen) and a spectrometer with rock-salt prism. Materials with a high silica content show small reflection at $\lambda > 3\ \mu$ except for a region near near $9\ \mu$; this latter reflection is reduced at higher temperatures up to 1000°c. Alumina shows small reflection in the region 6–11 μ. G. F. LOTHIAN

535.371

7320. Some properties of electron traps in ZnS : Cu phosphor. J. L. GILLSON, JR. Letter in *J. Opt. Soc. Amer.*, **44**, 341 (*April*, 1954).

A study is made of the rates of filling of different groups of trapping states in a cubic form ZnS–Cu phosphor and the relation of emission colour in phosphorescence to the particular groups.

G. F. J. GARLICK

535.371

7321. The luminescence of vitreous silica as a function of the temperature. V. GARINO-CANINA. *C.R. Acad. Sci.* [*Paris*] **238**, 1577–8 (*April* 12, 1954) *In French.*

Vitreous silica has an absorption band centred at 2420 Å. This gives rise to luminescence in a band at 2800 Å, diminishing to zero at 300–400°c, and in a second band at 3960 Å which may increase or decrease with temp. depending on the sample. If increase occurs a new emission max. appears over a certain temp. range at 4360 Å. S. T. HENDERSON

535.371

7322. Pressure effects in phosphorescence. L. REIFFEL. *Phys. Rev.*, **94**, 856 (*May* 15, 1954).

The influence of hydrostatic stress on the phosphorescence decay of thallium activated sodium iodide is shown to be very marked. Pressures as low as 100 kg/cm^2 produce readily observable effects. Interpretation in terms of pressure-increased effective trap depth is given. A.

535.371 : 539.185.9

7323. Effect of neutron bombardment on a zinc sulfide phosphor. A. W. SMITH AND J. TURKEVICH. *Phys. Rev.*, **94**, 857–65 (*May* 15, 1954).

An investigation has been made of the effect of neutron irradiation on the following properties of a copper-activated zinc sulphide phosphor: luminescence efficiency under ultraviolet and X-ray excitation, infrared quenching of luminescence, temperature dependence of luminescence efficiency, thermoluminescence, rise time of luminescence, decay of luminescence, and dependence of the rise time of luminescence on the previous history of the sample. In addition, the analogous changes in the dielectric constant of the phosphor on illumination were measured for samples damaged to varying degree by neutrons. It was shown that neutron damage can be removed by annealing at high temperature. A.

535.372

7324. Fluorescent spectra of solid solutions of naphthalene with added anthracene. F. LIPSETT AND A. J. DEKKER. Letter in *Nature* [*London*] **173**, 736–7 (*April* 17, 1954).

535.375.54 : 539.133

7325. Optical method of studying silicon organic compounds. The additivity of the intensities of the characteristic frequencies in the Raman spectra of light of allylsilanes. P. A. BAZHULIN, YU. P. EGOROV AND V. F. MIRONOV. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 3, 515–17 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-197.

See also Abstr. 7594 (1953).

535.376

7326. The luminescence of beryllium oxide. C. E. MANDEVILLE AND H. O. ALBRECHT. Letter in *Phys. Rev.*, **94**, 494–5 (*April* 15, 1954).

Particle excitation of BeO samples gives a strong fluorescence extending from above 4000 Å to about 2000 Å. Samples show long afterglow and optical stimulation. G. F. J. GARLICK

535.376

7327. Interpretation of electroluminescence effects in an excited phosphor. F. MATOSSI. *Phys. Rev.*, **94**, 1151–6 (*June* 1, 1954).

The consideration of electron transitions between valence band, conduction band and traps as presented by Randall and Wilkins' theory of luminescence growth is extended by including terms which take into account the emptying of traps by an electric field and the draining off of electrons by field-induced, non-radiative transitions. The result of the mathematical analysis corresponds to effects observed in a ZnS phosphor, embedded in a dielectric matrix, under the influence of a periodic electric field while continuously excited by ultraviolet radiation. These are a momentary illumination, an extinguishing effect, and the superposition of a ripple with twice the frequency of the field, whose amplitude decreases with increasing frequency. Some further observations are discussed qualitatively, utilizing the following assumptions: the draining effect ceases after some time; at low frequencies and for d.c. fields, a current effect counteracts the draining effect. A.

535.39 : 539.234

7328. Experimental determination of the reflection and transmission coefficients of thin films of CaF_2. P. BOUSQUET. *C.R. Acad. Sci.* [*Paris*] **238**, 1485–7 (*April* 5, 1954) *In French.*

Measurements are reported on evaporated films varying in optical thickness between 1000 and 20 000 Å, at wavelengths from 3987 to 6580 Å. It is found that the maximum values of reflection coefficient are not equal to the values suggested by interference theory. D. G. AVERY

535.41/.42

7329. The determination of absolute light phases through the measurement of intensity of the diffraction pattern of a grating. R. FLEISCHMANN AND A. LOHMANN. *Z. Phys.*, **137**, *No.* 3, 362–75 (1954) *In German.*

Methods are described whereby phase changes due to the passage of light through a thin film can be evaluated from intensity measurements. The thin film is deposited on glass and a grating scratched in it by removal of material. The intensities of the diffraction spectra are measured and from this the phase displacement, both for absorbent and non-absorbent material can be evaluated to within 2°. The quality of the supporting plate has very little effect on the results. The method is described in

detail for films such as LiF or Ag. The intensities are measured with a photocell and measurements are simplified if the dimensions of the grating spaces are measured with a microscope. Single and double grating procedures are described. The thin films are produced by vacuum evaporation and the grating spaces of the order of 1/100th of a millimetre, cut in with a razor blade. Measurements are reported for LiF films of thickness 160 mμ, Ag films 35–90 mμ, gold film thickness 5 mμ. S. TOLANSKY

535.417 : 531.711.1

Method for comparing a line standard and a wavelength of light. *See Abstr.* 7145

535.417 : 531.715

7330. Interference fringes of equal thickness in the measurement of length with light waves. G. SCHULZ. *Ann. Phys.* [*Leipzig*] **14,** *No.* 3–5, 177–87 (1954) *In German.*

A theory is developed for two-beam interference in a simple wedge. On the basis of this, spatial distribution, contrast and intensity distribution are calculated. Corrections due to the aperture are introduced for apertures 0–90°. It is demonstrated that two-beam interference of equal thickness, even using strictly monochromatic radiation, should show alternations caused by the aperture and not by the source. Proposed corrections as a function of the real aperture increase from 0 up to some 6% for 30° apertures. S. TOLANSKY

535.417 : 531.715.1

7331. Some problems arising from the use of interference for the precise measurement of plane-ended gauge blocks. The study of fringes from an air wedge. J. TERRIEN. *J. Phys. Radium,* **15,** 6 S–8 S (*April,* 1954) *In French.*

The length of steel gauge blocks can be found by comparison of the two fringe systems formed by interference between beams reflected from a reference glass surface, the upper gauge block surface and the surface plate on which the block is resting. For large gauge blocks, an error arises from the different character of the two sets of fringes, that from the upper surface arising from multiple reflections. The error is calculated and a method of measuring it is suggested. R. W. FISH

535.417 : 535.33.07

7332. Contribution to the attainment of a recording spectro-interferometer. R. DUPEYRAT AND A. ZMERLI. *C.R. Acad. Sci.* [*Paris*] **238,** 1207–9 (*March* 15, 1954) *In French.*

The practical details are given of a spectro-interferometer in which small movements of the interfering surfaces are obtained by piezoelectric means. The results of some preliminary trials are given. R. W. FISH

535.417 : 538.566

7333. Theory and application of high resolution interferometers. I. The etalon of Fabry and Perot. F. BRUIN. *Proc. K. Ned. Akad. Wetensch. B,* **56,** 515–25 (*Nov.–Dec.,* 1953).

The theory of the etalon is given in such a way as to make a comparison of its applications in different wavelength regions. Special attention is paid to microwaves and the measurement of the electric and magnetic properties of gases. A list of symbols and references is included. A.

535.417 : 538.566

7334. Theory and application of high resolution interferometers. II. Measurements in the optical and microwave region. F. BRUIN. *Proc. K. Ned. Akad. Wetensch. B.,* **56,** 526–37 (*Nov.–Dec.,* 1953).

The application of the formulae derived in Pt I to measurements of absorption and dispersion is discussed. As examples two microwave high-resolution interferometers are described. A.

535.417 : 538.566

7335. Theory and application of high resolution interferometers. III. Limitations to resolution. F. BRUIN. *Proc. K. Ned. Akad. Wetensch. B,* 57, 125–37 (*Jan.–Feb.,* 1954).

Investigates which effects limit the operation of an interferometer with multifold reflection, and how the highest sensitivity may be obtained. A.

535.42

7336. On the corpuscular theory of diffraction. F. J. WIŚNIEWSKI. *Ann. Phys.* [*Leipzig*] **14,** *No.* 3–5, 141–4 (1954) *In German.*

See Abstr. 4015 (1952), 8779 (1953). The usual formula for diffraction by a plane line grating is obtained by the application of Hamilton's principle. A. R. STOKES

535.42

7337. The rôle of diffraction waves in Fraunhofer diffraction phenomena. A. RUBINOWICZ. *Acta phys. Polon.,* **13,** *No.* 1, 3–13 (1954) *In German.*

Fraunhöfer diffraction phenomena can be explained by means of Kirchhoff theory in terms of the interference of waves arising from the diffracting boundaries. By a simple transformation, these diffraction waves can be treated by the corresponding formulae of Fresnel diffraction. This method is particularly useful for many special cases, such as a 3-dimensional diffracting boundary. R. W. FISH

535.42

7338. The non-existence of a theoretical limit of resolving power. G. TORALDO DI FRANCIA AND A. SÁEZ. *An. Real Soc. Españ. Fís. Quím,* **50 (A),** 17–26 (*Jan.–Feb.,* 1954) *In Spanish.*

The usual Rayleigh resolving power of an optical system requires the uniform illumination of the entrance pupil. It is shown that the central disk of the diffraction pattern, which determines the resolving power, can be reduced to any desired diameter by a suitable non-uniform distribution of the luminous complex amplitude over the pupil. R. W. FISH

535.42 : 532.72

7339. A general theory for the Gouy diffusion method. L. J. GOSTING AND L. ONSAGER. *J. Amer. Chem. Soc.,* **74,** 6066–74 (*Dec.* 5, 1952).

Equations are derived for the light intensity distribution and the positions of intensity zeros in a Gouy diffusion fringe pattern. This treatment goes beyond previous theory for the Gouy method by using a general mathematical approach and utilizing

two different methods for integrating the wave optical amplitude equation. One procedure results in a series expansion which converges rapidly for the lower fringes while the other development yields an expression converging rapidly for the central fringes. By specializing the fringe minima relation to the case of ideal diffusion, additional terms are obtained for the numerical factor, $(j + \frac{3}{4})$, in the interference condition of the original theory. Conditions which a cell mask must satisfy to minimize its disturbance of the Gouy fringes have been determined. A.

535.42 : 534.21

7340. Diffraction of light by several ultrasonic beams: intensity of the combination lines. S. Parthasarathy, M. Pancholy and H. Singh. *J. sci. industr. Res.*, **13 B**, 81–3 (*Feb.*, 1954).

A relation established between the intensities of combination lines in a superposed diffraction pattern produced by the passage of light through two ultrasonic beams has been found to hold good when three ultrasonic beams were used in the same medium to produce a complex diffraction pattern. The intensities of the satellite lines show that the effects reported for two ultrasonic beams generally hold good for several sound beams. A.

535.42 : 535.8

7341. Diffraction phenomena from a diaphragm with a scattering edge. H. Bender. *Optik*, **11**, *No.* 5, 244–8 (1954) *In German.*

Light diffracted by the edges of diaphragms, objective mounts, etc., is normally unimportant compared with the direct image-forming light. When photographing the sun's corona or schlieren images, the diffracted light assumes a much greater importance. Methods for reducing the diffracted light are described for both cases. Practical details are given and sample results illustrated. R. W. Fish

535.421

7342. Intensity consideration in reflection echelon. S. S. Mitra. *Sci. and Culture*, **19**, 404–5 (*Feb.*, 1954).

Equations are given relating intensity and phase difference in the reflected beam system of an echelon grating. D. G. Avery

535.434

7343. Light scattering from non-Gaussian chains. H. Benoit and P. Doty. *J. phys. Chem.*, **57**, 958–63 (*Dec.*, 1953).

The first two terms, following unity, in the expansion of the particle scattering factor, $P(\theta)$, are examined with reference to non-Gaussian chains. The first term is always equal to one-third of the mean square radius of gyration. Since this term is readily determined from light scattering, it is the obvious choice for characterizing the size of non-Gaussian chains. The ratio of this mean square radius to the value it would have if the Gaussian relation was valid for all chain lengths is calculated for (1) the constant valence angle chain with free rotation, (2) the worm-like (Porod) chain and (3) the constant valence angle chain with restricted rotation. In all cases the ratio decreases with decreasing chain length. The behaviour of the worm-like chain is similar to the constant valence angle chain when the valence angle or the restriction on rotation is large. The effect of excluded volume is also noted. The second term in the expansion is evaluated for ellipsoids and cylinders as well as for the worm-like chain. In all cases it is found to be positive, numerically small and insufficient to characterize the angular distribution of the scattered light. A.

535.434

7344. Scattering of light by large spherical particles. R. O. Gumprecht and C. M. Sliepcevich. *J. phys. Chem.*, **57**, 90–5 (*Jan.*, 1953).

The fundamental theory is discussed. A quantitative relationship between the Mie theory total scattering coefficient, K_t, and the apparent or actual scattering coefficient, K_a, is presented. K_a is shown to be a function of the total Mie scattering coefficient, the parameter α appearing in the Mie equations, and the half-angle, θ, of the cone which the transmitted-light-measuring instrument subtends with the illuminated spherical particle. These relationships between K_a and K_t were computed from the Mie equations and are particularly useful in the consideration of light scattered by large particles (i.e. values of α up to 400). The validity of the computed values for K_a was confirmed experimentally by measurements on prepared dispersions of glass beads in water. The validity of the transmission equation is discussed from the standpoint of the geometry of the optical system used for obtaining transmission measurements. A.

535.434 : 531.717 : 541.18

7345. Measurement of particle size distribution of phosphors. M. J. Bergin and K. H. Butler. *J. Electrochem. Soc.*, **101**, 149–54 (*March*, 1954).

A quick method of calculating particle size distribution from optical measurements of sedimentation rates is described. It is shown that the apparent mean diameter is greatly influenced by degree of dispersion of the powder and that reproducibility requires careful control of dispersion. A.

535.434 : 541.24

7346. Correction for absorption and fluorescence in the determination of molecular weights by light scattering. B. A. Brice, G. C. Nutting and M. Halwer. *J. Amer. Chem. Soc.*, **75**, 824–8 (*Feb.* 20, 1953).

Application of the light scattering method has been hindered frequently by colour or fluorescence, either intrinsic or adventitious, in the scattering solutions. The effects of colour absorption comprise three factors: attenuation of the primary and scattered intensities, an effect due to finite dimensions of the scattering volume and reflection of a portion of the primary beam at the exit window of the scattering cell. In the author's apparatus the first factor is compensated. The second and third factors are readily calculated. Fluorescence in a scattering solution is easily detected by use of a sharp cut-off filter to exclude scattered light from the phototube. Equations for the correction of fluorescence are based on measurement of the depolarization of the fluorescent light with this filter, and on measurement of apparent scattering ratios with a polaroid analyser oriented vertically and then horizontally. Corrections for absorption and for fluorescence were tested

separately by adding increments of absorbing and fluorescent dyes to macromolecular solutions. Turbidities of 0·01 cm^{-1} were determined with errors of less than 3% even when attenuation by absorption was more than 150 times that by scattering and even when 80% of the total phototube response was due to fluorescence. The absorption corrections presented are applicable also to the determination of fluorescence intensities in the presence of light absorption. A.

535.434 : 541.64

7347. Determination of the diffuse transmittance of opal glass and the use of opal glass as a standard diffusor in light scattering photometers. R. A. Brice and M. Halwer. Letter in *J. Opt. Soc. Amer.*, **44**, 340 (*April*, 1954).

Measurements on opal glass reported previously [Abstr. 1777 (1951)] are subject to an error which is now corrected; this does not affect turbidities and molecular weights previously reported.

G. F. LOTHIAN

535.51 : 531.717

7348. The apparatus for measuring the thickness of the thin film on metal plate. Y. Yoneyama and K. Imahori. *Sci. Pap. Coll. Gen. Educ. Univ. Tokyo*, **3**, 145–50 (*Dec.*, 1953).

The thickness of a film of denatured protein (1–300 Å) deposited on a metal slide is found by measurement of the change in ellipticity of light reflected from the slide before and after deposition. Standard polarized light techniques are employed using a half-shade analyser. Films of barium stearate of known thicknesses are used to calibrate the instrument. D. G. AVERY

535.515

7349. A new kind of double refracting filter. I. Šolc. *Czech. J. Phys.*, **4**, 53–66 (*Feb.*, 1954) *In Russian.* Summary (1 p.) *in English.*

The filter uses a number of double refracting plates in series, between crossed polaroids. The plates are of equal thickness and can be ground from one piece of material. Two modifications are considered. In the first, even plates have their axes inclined at a small angle to the odd plates. The second filter has the axes of the plates arranged like a fan, consecutively increasing by a constant small angle. The theory of the filter is given and some practical results.

R. W. FISH

535.542.1

7350. The theory and practice of the rotating compensators of Berek and Ehringhaus. C. Burri. *Z. angew. Math. Phys.*, **4**, *No.* 6, 418–24 (1953) *In German.*

The most used compensators in measurement of double refraction are those of Berek and Ehringhaus. The author shows that the relationship between angle and path difference is similar for both compensators. A practical method is suggested whereby either compensator may be calibrated. R. W. FISH

535.7 : 612.84

Physiological optics. *See Abstr.* 7932–45

535.82 : 612.84

Experiments with magnifying glasses. *See Abstr.* 7934

535.824 : 531.743

7351. A reflection goniometer for the microscope. B. Rankin. *Rev. sci. Instrum.*, **25**, 496–8 (*May*, 1954).

An instrument is described which measures angles accurately and rapidly under the microscope. A mathematical model displays the principles involved. It is shown that accuracy is achieved with an "optical lever arm" which moves when the eyepiece rotates, the arm being comparable to a 25 cm mechanical arm attached to the outside of the eyepiece. Rapid measurements are possible by the reading of relative positions of the "optical arm" on an illuminated scale which appears superimposed over the microscope field of view. The design and limitations of a practical, working instrument are discussed. A.

535.87

7352. Optical effect of flexure in vertically mounted precision mirrors. G. Schwesinger. *J. Opt. Soc. Amer.*, **44**, 417–24 (*May*, 1954).

Under their own weight, large concave mirrors, such as used in telescopes and various research equipment, may elastically bend beyond tolerable limits. The problem of preventing harmful mirror deformations arises in full severity when gravity has a substantial component in the direction of the optical axis. The less serious case of gravity acting perpendicular to the optical axis has been dismissed by one author as harmless for mirror sizes up to 120 in. However, disfigurations observed on much smaller vertically mounted mirrors are definitely traceable to elastic flexure by gravity. This paper briefly discusses the elastic deformation of an upright solid disk with a concave front surface and a plane back, supported along its edge by a distribution of radial forces which originate in the contact areas between disk and mount. The loss of image definition through flexure is related to the Fourier coefficients of the edge-pressure distribution in an explicit form simple enough as to permit the analysis of various types of mounts, as well as the synthesis of optimum mounting conditions. Numerical values and graphs are presented from which the optical effect can be appraised for different mirror shapes. The results are compared with observations made in practical tests. A.

535.89 : 621.373.43

7353. High voltage spark light source for spectroscopy with electronic control. Á. Bardócz. *Elektrotechnika*, **47**, 29–31 (*Jan.*, 1954) *In Hungarian.*

Two fixed spark gaps are adopted in this novel spark light source for which a complete circuit diagram is given. The impulse generator uses a double triode and the impulses are applied to the grid of a thyratron. A condenser is charged up to approximately 18 kV which voltage is equally distributed between two gaps S and F. When the grid of the thyratron receives a positive impulse the control spark gap S breaks down, followed by the breakdown of the analytical gap (F). The setting of the spark gap is not critical, and as no switching is required, the instrument is claimed to be more reliable and economical than conventional types. L. CSUROS

HEAT 536

536.22 : 530.162 : 532.13

Statistical mechanical theory of thermal conductivity of monatomic liquids. *See Abstr.* 7153

536.24 : 532.527

7354. The momentum and vorticity transfer theories of turbulent heat transfer. A. W. MARRIS. *Canad. J. Phys.*, **22**, 419–29 (*June*, 1954).

The case of heat transfer by a cylindrical turbulent region is examined further theoretically from the standpoint of the vorticity transfer analogy. The radial distribution of the eddy diffusivity for vorticity is considered and, on the logarithmic velocity distribution law for fully developed turbulence, this quantity is found to be negative throughout an interval at the outer boundary of the turbulent region. When this region is excluded from the relevant integrals, results are obtained for the Nusselt modulus and radial temperature distribution for the particular case of Prandtl number equal to the ratio of the eddy diffusivities for vorticity and heat, and are compared with the corresponding results on the momentum transfer analogy theory. A.

536.24 : 541.124

7355. Heat transfer in a flow accompanied by a chemical reaction. G. RIBAUD. *C.R. Acad. Sci.* [*Paris*] **238**, 1457–60 (*April* 5, 1954) *In French.*

Discusses two cases: (1) the chemical reaction takes place only on the solid surface over which the reacting fluid passes in a laminar flow (e.g. atomic H and a piece of W), and (2) the chemical reaction takes place only in the gas phase. F. LACHMAN

536.414 : 531.756

Volume change of Si at melting point. *See Abstr.* 7149

536.414 : 537.311.3 : 538.27

7356. Magnetic and resistance measurements in the neighbourhood of the melting-point on substances with negative volume change. A. KNAPPWOST. *Z. Elektrochem.*, **57**, *No.* 7, 618–24 (1953) *In German.*

Presents results of measurements of the anomalous diamagnetism and electric resistance above and below the melting point for Bi and Mg_2Pb. No aggregates having closer packing could be found at temperatures well below the melting-point. Above the melting-point a negative temperature coefficient was found for the electric resistance of Mg_2Pb. This coefficient (and the very small positive coefficient for liquid Bi) are explained by assuming further splitting of the residual aggregates of the original co-ordination. Such residual aggregates are believed to occur in all solids with a negative, or very small positive, volume change (the so-called space-weak solids). F. LACHMAN

536.422.15

7357. Study of the vapour pressure of caesium, rubidium and potassium chlorides. W. D. TREADWELL AND W. WERNER. *Z. angew. Math. Phys.*, **4**, *No.* 6, 459–70 (1953) *In German.*

The vapour pressures were determined by a transport method, using nitrogen as transport gas, the pressures being measured in the following temperature ranges: CsCl from 507 to 635°c, RbCl from 558 to 675°c, and KCl from 582 to 751°c. Results of fractionated sublimations with equimolar mixtures of CsCl with KCl, and with RbCl are reported, which show three or four typical steps in the pressure curve, produced by a certain amount of mixed crystal formation in the residue. A.

536.423 : 532.6

7358. Studies of evaporation of small drops. L. MONCHICK AND H. REISS. *J. chem. Phys.*, **22**, 831–6 (*May*, 1954).

The rates of evaporation of small droplets of diamyl sebecate (average radius $R \sim 10^{-4}$ cm) were measured in a Millikan oil-drop chamber, and observed to obey a law of the form $dR/dT = a/(1 + bR)$ which has been predicted by the theories of Fuchs and Frisch and Collins. Using a nonequilibrium distribution function of the velocities, the relationship has been rederived in a more rigorous fashion (over a limited range of conditions). Certain corrections in the constants a and b are introduced, and the validity of the Fuchs theory in this range of conditions is demonstrated. Using the formulation of Frisch and Collins, the law may be derived in the same form, subject to certain approximations. An empirical form of the Stokes–Cunningham law for the limiting velocity of fall in a dilute medium has been obtained for dicapryl sebecate in air. A.

536.423.15

7359. The calculation of vapor pressure curves from data at one temperature. A study of the Hildebrand rule. O. L. I. BROWN. *J. Amer. Chem. Soc.*, **74**, 6096–8 (*Dec.* 5, 1952).

All liquids obeying the Hildebrand rule will fall on the same curve of $\log(P_{mm}/T)$ versus $\log(T/\theta)$. $\log\theta$ is a constant obtained from any one pair of P and T values. A standard table is presented by means of which the entire vapour pressure curve of any liquid obeying the Hildebrand rule may be calculated from data at a single temperature. Departures from the Hildebrand rule are presented as a function of vapour volume in the case of some hydrocarbons. It is found that for straight chained paraffin hydrocarbons the excess entropy of vaporization at constant vapour volume is a linear function of the number of carbon atoms from 4 to 12 carbon atoms. A.

536.423.15 : 536.44

7360. The vapor pressure and critical constants of uranium hexafluoride. G. D. OLIVER, H. T. MILTON AND J. W. GRISARD. *J. Amer. Chem. Soc.*, **75**, 2827–9 (*June* 20, 1953).

Vapour pressure measurements were made on uranium hexafluoride from 0°c to the critical point. The vapour pressure of the solid is represented by the equation: $\log_{10} P_{mm} = 6{\cdot}38363 + 0{\cdot}0075377t - 942{\cdot}76/(t + 183{\cdot}416)$. Pressure data on the liquid from 64 to 116° are represented by equation: $\log_{10} P_{mm} = 6{\cdot}99464 - 1126{\cdot}288/(t + 221{\cdot}963)$, and above 116° by equation: $\log_{10} P_{mm} = 7{\cdot}69069 - 1683{\cdot}165/(t + 302{\cdot}148)$. Critical constants determined from experimental data are: t_c, $230{\cdot}2 \pm 0{\cdot}2°$ and P_c, $45{\cdot}5 \pm 0{\cdot}5$ atm. Calculated ΔH_v at the triple point, $64{\cdot}02 \pm 0{\cdot}05°$, was 6·82 kcal/mole. Calculated deviations from ideality were 0·0062 at 25° and 0·043 at 64·02°. A.

536.423.4

7361. Density fluctuations and supersaturation of vapours. Y. ROCARD. *C.R. Acad. Sci.* [*Paris*] **238**, 1391–2 (*March* 29, 1954) *In French.*

Calculation of the circumstances for which density fluctuations of a vapour might cause condensation. The region around the critical point where supersaturation is impossible is calculated from the van der Waals equation. C. TURNER

536.424.1

7362. On the accelerating influence of tin ions on the transition of white into gray tin. L. J. GROEN. *Proc. K. Ned. Akad. Wetensch. B*, **57**, 122–4 (*Jan.–Feb.*, 1954).

Tin, deposited by electrolysis from a tin salt solution at a temperature of −50°C, i.e. below the transition-point of white tin into grey tin (13·2°C), is white tin. This seems inconsistent with Cohen's theory, according to which the accelerating effect of tin ions in solution on the rate of transition of white into grey tin can be ascribed to internal electrolysis in local elements white tin/solution/grey tin. It is further shown that only tin ions, independent of valency or complex-form, even in very small quantities, have an accelerating influence on the transition of white into grey tin. A.

536.453

7363. A segmented-mirror solar furnace for high-intensity thermal radiation studies. R. GARDON. *Rev. sci. Instrum.*, **25**, 459–63 (*May*, 1954).

A solar furnace is described, in which an array of many small plane mirrors is used to produce radiation of practically uniform intensity (up to about 5·5 cal/cm² sec) over an area 5 cm square. This relatively large area of irradiation is required for experiments in which edge effects must be kept to a minimum, and could not have been obtained by means of a conventional continuously curved mirror of reasonable focal length and of moderate cost. The performance over a 15 month period is analysed. A.

536.46

7364. Theoretical proof of the cellular structure in flames. F. SCHULTZ-GRUNOW. *Z. Elektrochem.*, **57**, *No.* 8, 627–9 (1953) *In German.*

Derives the cellular structure of flames from the ideas of the sources of heat and of matter, and gives a criterion for the cell size; the theory developed is found to be in agreement with the observed relationships. F. LACHMAN

536.46.07

7365. Vortex burner—a useful tool for studying the flame stability of gaseous fuels and fuel mixtures. P. F. KURZ. *Rev. sci. Instrum.*, **25**, 418–21 (*May*, 1954).

A vortex burner has been developed that permits direct comparison of flame stability of fast-burning and of slow-burning gaseous fuels and their mixtures. In this burner, air is introduced tangentially into a chamber to generate a vortex. The vortex is then accelerated by means of a converging nozzle which directs the air into a throat section where fuel is injected radially from ports in the periphery of the throat. The flame is stabilized in space in a divergent, pressure-recovery section and burns as a whirling inverted cone. Flame stability is independent of tangential velocity at any given air rate. However, changes in other parameters, such as throat diameter and length of the pressure-recovery section, do have an effect on flame stability. The results suggest that further studies with longer recovery sections are of interest. Likewise, the effect of gas temperature on flame stability will be studied. A.

536.461

7366. Combustion wave stability and flammability limits. J. B. ROSEN. Letter in *J. chem. Phys.*, **22**, 750–1 (*April*, 1954).

A simplified stability condition (permitting the investigation of the thermal stability of steady-state solutions to equations developed for a laminar combustion wave) is applied for determining the region of stability in the parameter space of a model flame-propagating medium with simple kinetics. The result of mathematical treatment suggests that the stability limit has its physical counterpart in the limit of flammability. F. LACHMAN

536.461

7367. Flame turbulence measurements by the method of helium diffusion. A. A. WESTENBERG. *J. chem. Phys.*, **22**, 814–23 (*May*, 1954).

A technique is described for measuring transverse turbulence intensity in flames which makes use of the diffusion of helium. The latter is detected by a thermal conductivity method. The effects of various experimental parameters and the reliability of the technique are discussed. Results obtained in highly turbulent flames stabilized on various baffles in a 5 cm × 20 cm duct are given, and compared with results obtained under comparable cold flow conditions. It appears that, under the conditions of these experiments, the amount of "flame-generated" turbulence detectable at a fixed point in the duct by this technique is probably small. A.

536.462

7368. Measurement of temperature distribution in a low-pressure flat flame. R. FRIEDMAN AND E. BURKE. *J. chem. Phys.*, **22**, 824–30 (*May*, 1954).

The temperature distribution in a very lean, flat propane–air flame was measured by the thermocouple method, at a pressure of 0·0594 atmos. The temperature change occurred in a zone about 3 cm thick. Wall-quenching was minimized by employing a burner tube diam. of 25 cm. The thermocouple was made from 12-micron wire, coated with ceramic to avoid catalytic effects. One hundred experimental traverse points were obtained, with a standard deviation of ±0·016 cm. The burning velocity was also measured, and was found to vary with the inverse 0·30 power of pressure. This is in agreement with Egerton and Sen's result, obtained over a more limited range of pressure. The temperature pattern was analysed mathematically to obtain the pattern of heat release rate, taking into account the variation with temperature of thermal conductivity and specific heat. It was found that the heat release began at 300°C, attained a maximum value of 1·2 cal/cm³/sec at 1100°C, was nowhere negative, and was finite over a

zone about 2 cm thick. The maximum temperature of the flame was 1332°C. The result obtained for the "ignition point" was found to be extremely sensitive to the exponent giving the temperature dependence of the thermal conductivity. Some calculations relating to the chemical kinetics of the flame are described. A.

536.48 : 532.122

7369. The compressibility of liquid normal hydrogen from the boiling point to the critical point at pressures up to 100 atmospheres. H. L. JOHNSTON, W. E. KELLER AND A. S. FRIEDMAN. *J. Amer. Chem. Soc.*, **76**, 1482–6 (*March* 20, 1954).

A description is given for an apparatus used to determine equation of state data for liquids at low temperature. Measured values of P *v.* V isotherms of normal liquid H_2 are tabulated for seven temperatures between 20·38 and 32·58°K. The data have been replotted as isochores, the straight-line character of which can be adequately described by $P = A_v + B_vT$ with $B_v = -7{\cdot}11 + 437(1/V)$; values of A_v and B_v are given at integral values of the specific volume. Comparison of experimental results with calculations based on two proposed models for liquids are made and the agreement is found to be unsatisfactory. A.

536.48 : 536.631

7370. The specific heat of polymerized Araldite and Wood's metal between 1·5 and 20°K. D. H. PARKINSON AND J. E. QUARRINGTON. *Brit. J. appl. Phys.*, **5**, 219–20 (*June*, 1954).

Araldite varnish and Wood's metal are frequently used in the construction of low temperature apparatus. Their heat capacities have been determined in the temperature range 1·5 to 20°K, and over most of it, weight for weight, they are found to be very much higher than those of copper. A.

536.48

7371. Indirect measurement of the fountain effect. C. J. N. VAN DEN MEIJDENBERG, K. W. TACONIS, J. J. M. BEENAKKER AND D. H. N. WANSINK. *Physica*, **20**, 157–64 (*March*, 1954).

Two containers filled with He II, are vertically connected over a narrow orifice or capillary, the lower container being immersed in a helium bath. On raising the temperature in the upper container a reduction of the pressure is observed in the lower container. This decrease in pressure is measured at temperatures between 1·4°K and the λ-point, so that at any temperature of the bath the temperature of the upper container is raised by amounts between 0·002 and 0·35 deg. In interpreting their experiments the authors invoke an analogy with the thermodynamics of a vertical helium film and argue that the observed reduction in pressure is, apart from small correction terms, equal to the thermomechanical excess pressure corresponding to the excess temperature of the upper container. The experimental results are thus checked against the fountain pressure as calculated according to H. London from experimental specific heats by way of the entropy. Whereas this test is satisfactory, comparison with experimental fountain pressures reveals small but systematic discrepancies.

R. EISENSCHITZ

536.48

7372. On the theory of liquid helium. I. PRIGOGINE. *Advances in Phys.*, **3**, 131–48 (*April*, 1954).

The author employs a cell model similar to that of classical liquids, in order to derive equilibrium properties of helium without introducing *ad hoc* concepts. At very low temperatures the atoms are supposed to be localized and uniformly distributed. This assumption suffices for obtaining the right order of magnitude of the volume energy relation for both isotopes which, up to here, differ on account of their mass only. A fair estimate of excess energy and volume in isotopic mixtures is made and phase separation of the liquid isotopes at absolute zero is predicted. In considering higher temperatures, only those thermal excitations are taken into account which can be described as fluctuations of density; they are shown to yield the right order of magnitude of the entropy. Taking account of the different types of statistics, the existence and absence of a λ-transition in He^4 and He^3 respectively is explained in terms of the energy necessary for forming a cluster.

R. EISENSCHITZ

536.48

7373. Storage and transfer of liquid helium. A. WEXLER. *Rev. sci. Instrum.*, **25**, 442–5 (*May*, 1954).

The performance of large, efficient storage containers for liquid helium is indicated, and liquid helium transfer techniques permitting correspondingly efficient use of the stored liquid are described. A.

536.48

7374. Superfluidity and dissipative processes in liquid He II. J. G. DASH. *Phys. Rev.*, **94**, 825–8 (*May* 15, 1954).

A phenomenological theory of superfluidity of He II is constructed upon the two-fluid models of Tisza and Landau. The postulate that phonons partially represent the thermal energy of the liquid is employed to explain the dependence of critical velocities upon the size of the liquid region. A new assumption, of the production of phonons by the motion of large clusters of superfluid particles, provides a description of the transition between superflow and dissipation at flow velocities exceeding critical. A.

536.48

7375. The inertia of heat flow in liquid helium II. H. E. HALL. *Proc. Phys. Soc.* [*London*] *A*, **67**, 485–94 (*June*, 1954).

Measurements have been made of the mechanical reaction on a source of heat in liquid helium II. On the two-fluid model this reaction is due to the inertia of the fluids. The results are consistent with the predictions of the two-fluid model, although the conditions of the experiment were chosen so that dissipative effects were present which are not given by that model in its present form. This result gives experimental justification for retaining the two-fluid model under such conditions. A.

536.48

7376. A possible model of liquid He^3. H. N. V. TEMPERLEY. *Proc. Phys. Soc.* [*London*] *A*, **67**, 495–504 (*June*, 1954).

It is shown that many of the properties of liquid He^3, including its two changes of state, are predicted

semi-quantitatively by a model in which one applies corrections of van der Waals type to the free energy of a perfect Fermi gas. Various other models are also discussed in the light of available experimental evidence. A.

536.48

7377. Superfluid dynamics of liquid He II. J. G. DASH. *Phys. Rev.*, **94**, 1091–6 (*June* 1, 1954).

Some implications of the co-operative cluster model are explored. Supercritical flow of liquid He II through capillaries is discussed and compared with experiment, as a test of the theory and as a means for deducing some information on the postulated wall friction mechanism. The general flow characteristics of the actual mobile film of He II and the present film model flowing under the influence of gravity are found to be in substantial agreement. A.

536.48 : 536.423.15

7378. A note on the vapour pressure of liquid He II and liquid He^3. S. M. BHAGAT AND P. K. KATTI. *Sci. and Culture*, **19**, 461–2 (*March*, 1954).

If it is assumed that both the gas and the liquid can be treated by gas statistics with an appropriate ground state energy difference, then that difference is the same for both He^3 and He^4 at 1°K. R. O. DAVIES

536.48

7379. The attenuation of second sound in liquid helium II above 1°K. K. R. ATKINS AND K. H. HART. *Canad. J. Phys.*, **32**, 381–92 (*June*, 1954).

The second sound was in the form of a pulsed continuous wave with a pulse length of 1 to 2 msec and a carrier frequency of 10 or 20 kc/s. The change in amplitude of the pulse was measured as the distance between the transmitter and the receiver was varied. To avoid boundary effects, no propagation tube was used and allowance had to be made for the spreading of the second-sound beam. The attenuation was found to increase with increasing second-sound amplitude. The attenuation extrapolated to zero amplitude had a finite value which increased rapidly as the temperature was lowered towards 1°K. Its order of magnitude was too large to be explained by viscosity effects, but was in good agreement with a thermal conductivity effect predicted by Khalatnikov. A.

536.483

7380. Some improvements in the technique of physical experiments at very low temperatures. P. G. STRELKOV. Letter in *Zh. eksper. teor. Fiz.*, **24**, *No.* 2, 248 (1953) *In Russian.*

Activated charcoal (temp. 4 — 1·5°K) is made to adsorb He introduced into the apparatus at room temperature and pressure ~ order of magnitude 0·1 — 10 mm Hg, and produces a vacuum which eliminates quite well the heat exchange due to residual gas. Another improvement consists in the use of joints consisting of bronze flanges between which a rhombic-section ring is clamped (the same principle as Ipatieff's closure in high-pressure autoclaves).

F. LACHMAN

536.521

7381. Ardonox—a new Ardometer (radiation pyrometer). F. LIENEWEG AND A. SCHALLER. *Siemens-Z.*, **28**, 67–73 (*Feb.*, 1954) *In German.*

Unlike the older form, the new instrument works almost entirely within the infrared range, and uses an optical system of the Féry type. The concave mirror has an evaporated Al reflecting film with a protecting layer of quartz. Entry of dust and air-currents is prevented by a front window of synthetic film, 0·1 mm thick, which is transparent far into the infrared; the radiation loss due to the film at room temp. is only 30%. The radiation-sensitive element is a thermopile of 23 NiCr–Constantan couples; the output is: 1 mV — 100°, 5 mV — 300°, 10 mV — 400°, 30 mV — 600°C. Ranges obtainable are: 500 to 600°C with a directly-connected indicator or (chopper-bar) recorder; 400°C with a d.c. amplifier of the a.c.-modulated type; 400°C with an (electronic) potentiometric recorder; 150°C with a light-beam galvanometer; 50°C with a photoelectric d.c. amplifier. Typical scale-shapes are given for ranges of 0–50°, 20–75°, 50–300° and 100–600°C. Ambient temp. compensation is effected by a temp.-sensitive resistor in parallel with the thermopile, and a series-connected, battery-fed resistance bridge with three fixed and one temp.-sensitive arms. Minimum radiator source diameter is 9 cm at 10 cm distance, 19 cm at 100 cm, 52 cm at 400 cm. C. F. PIZZEY

536.521 : 612.84

7382. A note on the selection of observers for primary standard optical pyrometry. M. C. PROBINE AND S. BERTAUD. *Brit. J. appl. Phys.*. **5**, 227–8 (*June*, 1954).

The effect of the spectral sensitivity of the eye of the observer on the accuracy with which the International Temperature Scale can be realized above the gold point, by the present instrumental method, is discussed. A.

536.631

7383. The specific heat of small particles at low temperatures. G. JURA AND K. S. PITZER. *J. Amer. Chem. Soc.*, **74**, 6030–2 (*Dec.* 5, 1952).

The theory is developed for the specific heat of a very finely divided solid at low temperatures. Each particle is treated as if it were a separate molecule, but the usual theory of vibrations of a solid is used to estimate the frequencies of the normal modes. Numerical values are given for 100 Å cubes of aluminium in the range 1–6°K. At 1°K the gross translation and rotation of whole particles make the principal contributions. It is concluded that the heat capacity of a finely divided solid will be higher than that of the infinite crystal up to the temperature at which the vibrations become classical. A.

536.631

7384. The effect of particle size on the heat capacity of titanium dioxide. J. S. DUGDALE, J. A. MORRISON AND D. PATTERSON. *Proc. Roy. Soc. A*, **224**, 228–35 (*June* 22, 1954).

The heat capacities of four samples of titanium dioxide, differing in particle size, were measured in the temperature range 12 to 270°K in order to determine the effect of particle size on the specific heat. Contrary to the prediction of existing theories, no effect attributable to a change in particle size was found in the low-temperature region. On the other hand, above 50°K a pronounced particle-size effect is evident which may be accounted for qualitatively as an effect on the optical modes of vibration of the

solid. The complexity of the titanium dioxide crystal structure precludes any quantitative theoretical calculations. A.

536.631 : 536.66 : 536.7

7385. The thermodynamics of boron nitride; low-temperature heat capacity and entropy; heats of combustion and formation. A. S. DWORKIN, D. J. SASMOR AND E. R. VAN ARTSDALEN. *J. chem. Phys.*, **22,** 837–42 (*May*, 1954).

The low-temperature heat capacity of microcrystalline boron nitride has been measured up to 300°K. It has been found that in the range from 20 to 65°K the heat capacity follows a T^2 relationship rather than the usual Debye T^3 law, and this has been explained as resulting from the layered, quasi-two-dimensional lattice of boron nitride. The Debye-type characteristic (two-dimensional) temperature is $\theta_2 = 598$°K. At $298{\cdot}16$°K $C_p = 4{\cdot}78_3$ cal/mole deg and $S^0 = 3{\cdot}67_3$ e.u., of which $0{\cdot}034$ has been extrapolated below 20°K. Derived thermodynamic functions have been tabulated at 10° intervals between 20 and 300°K. The heat of combustion of boron nitride in a conventional bomb calorimeter to yield amorphous boric oxide and elemental nitrogen has been determined to be $90{\cdot}2 \pm 0{\cdot}5$ kcal/mole. From this value and other established thermal data the heat of formation of boron nitride is exothermic $60{\cdot}7 \pm 0{\cdot}7$ kcal/mole. A.

THERMODYNAMICS 536.7/.8

536.7

7386. The thermodynamics of irreversible processes. K. POPOFF. *Z. angew. Math. Phys.*, **5,** *No.* 1, 67–83 (1954) *In French.*

Taking the Onsager relations, for which L_{ik} in $x_i = \sum_k L_{ik} X_k$ is symmetrical, the equations determining an irreversible process are calculated. These equations are used in the general case, where all terms in the series for ΔS are kept. Special cases considered are: heat transference from one system to another and heat conduction in a homogeneous cylinder. The equations are applied to the phase theory for two components. C. TURNER

536.7

7387. The *H*-theorem and the unitarity of *S*. M. INAGAKI, G. WANDERS AND C. PIRON. *Helv. Phys. Acta*, **27,** *No.* 1, 71–3 (1954) *In French.*

A proof, independent of that originally given by Stueckelberg [Abstr. 4776 (1953)] is supplied to show that Boltzmann's *H*- theorem holds for finite, positive-definitive transition probabilities $A_{ik} (= |S_{ik}|^2)$. A consequence of the unitarity of S is that the A_{ik} are doubly normalized. G. FIELD

536.7 : 536.44

7388. The thermodynamics of critical phenomena in gases. J. F. LEE. *J. Franklin Inst.*, **256,** 245–8 (*Sept.*, 1953).

Sonic velocity measurements have been used for some time to determine the specific heats of gases at low frequencies following the suggestion of Einstein (1920) that the reaction rates of reactive gas mixture could be found from similar measurements. Howeve the equation for sonic velocity expressed in terms the ratio of the specific heats and the isothermal bul modulus becomes indeterminate when applied to th critical point. In this paper a determinate expressio for the sonic velocity at the critical point is derive which permits a direct solution for the constan volume specific heat as a function of the critical value of temperature, specific volume, sonic velocity an Joule–Thomson coefficient. The calculated value obtained from this expression are examined in com parison with existing data. Finally the approach t the problem from the standpoint of classical thermo dynamics is appraised in the light of some finding from statistical thermodynamics. A

536.7 : 538.

7389. The introduction of electromagnetism into thermomechanics. J. E. VERSCHAFFELT. *Bull. Acad Roy. Belgique Cl. Sci.*, **39,** *No.* 11, 922–36 (1953) **40,** *No.* 2, 91–7 (1954) *In French.*

536.7 : 541 12

7390. A note on the thermodynamics and kinetics of open and steady state systems. A. BIERMAN. *Bull. math. Biophys.*, **16,** 97–101 (*March*, 1954).

Some conclusions of irreversible thermodynamics are summarized. It is shown that θ, the rate of irreversible entropy production is not minimized in the steady state. It is also postulated that multiple steady states are possible in nonlinear kinetic systems, giving rise to situations of possible biological interest. The necessity of examining particular kinetic models is mentioned. A.

536.7 : 541.133.1

The thermomechanics of electrolysis. *See Abstr.* 7818

536.71

7391. The equation of state of fluids according to kinetic theory. Y. ROCARD. *Rev. sci.* [*Paris*] **90,** 387–418 (*Nov.–Dec.*, 1952) *In French.*

An attempt to find an equation of state involving few parameters and with some theoretical support which is valid for simple substances over the whole fluid region. Starts with the observation that van der Waals' equation implies that $V \to b$ as $p \to \infty$ whereas for a close-packed arrangement one should have $V \to 0{\cdot}338b$. Hence suggests two alternatives to van der Waals' equation of which the simpler is $p = RTV^2/(V - \frac{1}{3}b)^3 - a/V^2$. This is an improvement but still gives an incorrect form for the second virial coefficient and fails to fit the critical data. A series of semi-empirical corrections are introduced which involve making a and b functions of V and T. There are extensive numerical tables comparing theory and experiment and a review of existing knowledge concerning the behaviour of pure substances near the critical point. R. O. DAVIES

536.71

7392. Determination of the critical magnitudes for real gases and liquids, and a general equation of state for saturated vapours. E. KORDES. *Z. Elektrochem.*, **57,** *No.* 8, 731–8 (1953) *In German.*

New methods are indicated for better graphic

valuation of θ, π and ρ_0 (or ϕ) from measurements elow the critical point. A general equation of state or saturated vapours or for the vapour ⇌ liquid quilibrium is developed, viz.

$$p = \frac{RT}{(V_g + V_l) + \left(\frac{R\theta}{\pi} - 2\phi_M\right)} = \frac{RT}{(V_g + V_l) + \text{const}}$$

where V_g and V_l are the molar volumes of gas and quid, respectively, and ϕ_M the critical molar volume. A good agreement with experiment is found for CO_2, CH_4, PH_3, C_2H_2, CH_3OH and HCl. F. LACHMAN

536.71 : 533.7

Second virial coefficients of He^3 and He^4. *See Abstr.* 7182

536.722

393. Apparatus for differential enthalpy-analysis. C. EYRAUD. *C.R. Acad. Sci.* [*Paris*] **238,** 1511–12 (*April* 5, 1954) *In French.*

The new technique consists in imparting to both he sample tested and the standard substance the bility to conduct electric current by adding to them suitable quantity of an inert conductor (e.g. graphite n experiments with Al_2O_3 and its hydrates). Both ubstances are placed in two adjacent thin-walled ica tubes embedded in the heating block. The eating current (a.c.) is passed automatically through ne of the two cells to maintain equality of tem- erature during the heating of the system. A watt- neter and a stopwatch enable the curve of electric ower to be plotted against time, the integral of the urve yielding the enthalpy of transformation.

F. LACHMAN

536.75

394. The minimum production of entropy. J. E. ERSCHAFFELT. *Bull. Acad. Roy. Belgique Cl. Sci.*, **0,** *No.* 1, 8–17 (1954) *In French.*

Criticizes P. Mazur's Abstr. 823 (1953)] thesis, that ne entropy of a system which is in a constant state long its boundaries goes to a minimum if the system ecomes stationary. P. Glansdorff [Abstr. 1277, 2390 953)] omits the heat exchange by radiation and also ixes up source and production of entropy. His ethods of calculation and the conclusions he draws e also criticized. C. TURNER

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.21

395. The field *E* and displacement *D* of a point, arge in space. É. DURAND. *C.R. Acad. Sci.* [*Paris*] **8,** 1478–80 (*April* 5, 1954) *In French.*

The charge is assumed to be located at the origin co-ordinates and a polarization potential is defined ith respect to an arbitrary curve passing through the igin. This provides two methods of deriving the ctric field at any point and has the advantage that the form of the relations is unchanged for regions inside polarized media. A. E. KAY

537.226.1.08

7396. Two new methods for the determination of the electric constants of liquids in the decimetre wavelength region. O. HUBER. *Z. angew. Phys.*, **6,** *No.* 1, 9–14 (1954) *In German.*

Tan δ and ε' are obtained from the amplitude and phase of a reflection signal in a vertical coaxial system at 300 Mc/s. These are found by varying the depth of liquid above the short-circuited base and thus avoiding all mechanical motion of pistons or detector probe. For high-loss liquids the generator is coupled at an open-circuit end while for low-loss liquids both ends are short-circuited. The theory required for computation is given. D. H. WHIFFEN

537.226.2/.3 : 535.345

7397. Electrical and optical properties of hygroscopic crystals with water of crystallization. L. HECHLER, K. H. HELLWEGE AND K. RETTIG. *Z. angew. Phys.*, **6,** 205–9 (*May*, 1954) *In German.*

The permittivity and loss factor of crystalline $Ce_2Zn_3(NO_3)_{12} \cdot 24H_2O$ and $Zn(NO_3)_2 \cdot 6H_2O$ were measured in the frequency range 9 kc/s to 42 Mc/s and over the temperature range 20°c to −213°c. Maxima occurred in both cases between −20°c and −30°c due to the ice formed on the surface which has a eutectic point in this range as shown by optical means. The isomorphous praesodymium salt shows no change in absorption over the range.

G. F. J. GARLICK

537.226.2/.31 : 535.343.2–14

7398. The dielectric constant and loss factor measurement of cetyl alcohol at 3·4 cm and 7·5 cm wavelengths. M. TAKEYAMA. *J. Sci. Hiroshima Univ. A*, **17,** 115–20 (*Aug.*, 1953).

537.226.2 : 548.7

7399. Theory of ferroelectrics. A. F. DEVONSHIRE. *Advances in Phys.*, **3,** 85–130 (*April*, 1954).

General review containing some new material particularly on piezoelectric effects. Ferroelectrics are divided into two classes, (*a*) Rochelle salt or KH_2PO_4 types with orthorhombic or tetragonal symmetry, and (*b*) perovskites with cubic symmetry. The thermodynamics of crystals and piezoelectric and electrostrictive constants are discussed, and the thermodynamics of the transition between ferroelectric and nonferroelectric states of a crystal is discussed also. Atomic models and dynamic theories of ferroelectric crystals are described for the main classes. C. A. HOGARTH

537.226.2

7400. Anomalous temperature coefficient of permittivity in barium titanate. K. W. PLESSNER AND K. A. COOK. Letter in *Nature* [*London*] **173,** 682–3 (*April* 10, 1954).

When $BaTiO_3$ is heat cycled through 0·1 deg at 125°c (1 deg below the Curie point), a negative temperature coefficient is observed. This can be explained if the ratio of the cubic and tetragonal phases is unchanged by small temperature changes (<0·3 deg) because the high negative coefficient of the cubic phase masks the positive coeff. of the tetragonal phase. J. H. MASON

537.226.2 : 548.736.4

7401. Structural changes in $BaTiO_3$. J. FOUSEK. Letter in *Czech. J. Phys.*, **3**, 315 (*Nov.*, 1953) *In Russian.*

When admixed Sr reaches 45% [mol. % of alkaline earth ions?] the titanate lattice becomes cubic. The mean coefficient of linear expansion of pure $BaTiO_3$ was found to be $5{\cdot}1\times10^{-6}$/deg c from 30 to $121{\cdot}7$°c and $10{\cdot}3\times10^{-6}$/deg c from $124{\cdot}1$ to 310°c. A discontinuous change of $0{\cdot}07$ Å^3 in the cell volume was found at the transition temperature. The phase change at 122°c is therefore not thought to be a second-order transition. A. L. MACKAY

537.226.8

7402. Threshold field and free energy for the antiferroelectric-ferroelectric phase transition in lead zirconate. A. P. DEBRETTEVILLE, JR. *Phys. Rev.*, **94**, 1125–8 (*June* 1, 1954).

Sawaguchi and Kittaka obtained the threshold field of $PbZrO_3$—that field necessary to change the antiferroelectric to the ferroelectric phase—below the Curie temperature. The free-energy difference is the difference between the area under the ferroelectric portion of the curve and that under the antiferroelectric portion. An expression for free-energy difference has been obtained as a function of voltage, by eliminating the temperature parameter. This experimental relationship is compared with the author's theoretical expression—one that involves the product of the constant spontaneous polarization (16×10^{-6} coulomb/cm^2 in the ferroelectric phase), the threshold voltage and the molar volume (43 cm^3); the free energy so calculated is small—of the order of 4 calories/mole at 25 kV/cm. Equations are given for calculating the threshold field-strength and free-energy difference as functions of temperature. The equation for threshold field-strength resembles the Clapeyron–Clausius equation, with field strength analogous to pressure and spontaneous polarization analogous to volume. The threshold voltage *v.* the downward shift of the Curie temperature is in good agreement with the experimental results of Sawaguchi and Kittaka. A.

537.226.8 : 621.317.333 : 621.315.618

7403. Some measurements of the relative dielectric strength of gases. N. R. MCCORMICK AND J. D. CRAGGS. *Brit. J. appl. Phys.*, **5**, 171–3 (*May*, 1954).

Measurements of the breakdown voltages of small sphere gaps in various gases have been made, partly to check existing results but also to provide new data. Various electronegative gases, such as SF_6, Cl_2, etc., were studied, taking nitrogen as a standard gas, and the data are tabulated. A brief discussion of these results is given. A.

537.228.2 : 541.182.2

7404. The distortion of aerosol droplets by an electric field. C. T. O'KONSKI AND H. C. THACHER, JR. *J. phys. Chem.*, **57**, 955–8 (*Dec.*, 1953).

An equation has been derived for the distortion of a liquid aerosol droplet under the influence of a parallel electric field. The equation, valid for static fields in insulating media, can be reduced to a simple form for many cases of interest. Numerical values c the distortion are computed for water and dioct phthalate droplets. The droplet becomes longer in th direction of the field, whether its dielectric constan is greater or less than that of the surrounding mediun because of the decrease in total electrostatic fre energy of the system which accompanies this distortio in both cases. This effect is of interest in connectio with size studies of aerosol droplets. It leads t predictions of an electric birefringence and of effect involving the scattering of electromagnetic radiatio by liquid aerosol systems. A new method is propose for studies of size distribution in aerosol system containing large liquid droplets. It would employ th above effect to induce, by means of a periodic electri field, the natural resonant vibrations of the liqui droplets, which could be observed by the resultin modulation of the birefringence or of the ligh scattered by the aerosol. The distortion is also c interest for the study of dynamic surface tension b means of potentially very accurate measurements c the resonant frequencies of airborne or hangin drops. A

ELECTRIC CONDUCTION . CURRENTS 537.

537.311.3

7405. Resistivity changes in copper, silver, and gol produced by deuteron irradiation near 10°K. H. C Cooper, J. S. KOEHLER AND J. W. MARX. Letter i *Phys. Rev.*, **94**, 496 (*April* 15, 1954).

12 MeV deuterons were used, the flux bein 10^{17} deuterons/cm^2. The resistivity increase wa studied as a function of annealing temperature, an abrupt drops in resistivity were observed in Cu an Ag at around 35°K. E. H. SONDHEIME

537.311.3

7406. Resistance anomalies in some rare-earth metals. R. J. ELLIOTT. *Phys. Rev.*, **94**, 564–8 (*May* 1954).

It is shown that the anomalies observed in th resistance of the lighter rare-earth metals can b explained in form and order of magnitude by a simpl model of the interaction between the conductio electrons and the *f* electrons which are tightly boun to each atom. The *f* electrons interact with th crystal field set up by the surrounding atoms, so tha there is a Stark splitting of their energy levels. Th extra resistance arises because ion cores with *f* electron in different states present different cross-sections t the conduction electrons, and also because th conduction electrons can knock ions from one stat to another. All exchange effects are neglected. A

537.311.3

7407. On the thermal and electrical conductivity o semiconductors. H. J. GOLDSMID. *Proc. Phys. Soc [London] B*, **67**, 360–3 (*April*, 1954).

The ratio μ/λ (μ is carrier lattice mobility; λ thermal conductivity) is shown to vary rapidly an fairly smoothly with mean atomic weight.

C. A. HOGARTH

537.311.33

7408. Graphical representation of the semiconductor Hall effect. L. P. HUNTER. *Phys. Rev.*, **94**, 1157–60 (*June* 1, 1954).

The semiconductor Hall effect is represented in terms of an ellipse relating the Hall mobility and resistivity. Various uses and extensions of this representation are given which serve to correlate the important features of the Hall effect in semiconductors. The effects of excess current carrier lifetime and the nonequality of Hall and drift mobility ratios are discussed. A.

537.311.33 : 537.583 : 621.385.032.216

7409. Some measurements of the electrical conductivity, thermoelectric power and other properties of the coating in the oxide-coated cathode. C. M. LOVETT. *Proc. Phys. Soc.* [*London*] *B*, **67**, 387–94 (*May*, 1954).

Earlier measurements of the electrical conductivity of (Ba, Sr)O led to different observations of its temperature dependence, from which, in some cases, it was concluded that two characteristic work functions exist and therefore a complex mechanism of conduction. In this investigation measurements of the conductivity carried out under carefully controlled conditions indicated that, for the range of temperature considered, only one work function exists. This was confirmed by the thermoelectric power measurements. From comparison between the internal coating conductance and the anode–cathode conductance it is concluded that low electron emission is associated with a high-resistive surface layer of high work function. A.

537.311.33 : 539.234

7410. Semiconducting films of antimony. J. COHEN. *J. appl. Phys.*, **25**, 798–801 (*June*, 1954).

Thin films of antimony were condensed on to substrates at various temperatures. Films deposited at liquid oxygen temperatures showed large negative temperature coefficients of resistance. In general, reversible resistance changes occurred if the films were cooled below a temperature previously reached; irreversible changes took place if the films were heated above that at which they were prepared. Activation energies were calculated from log R *v.* $1/T$ curves and gave values of $\sim 0{\cdot}07$ eV for low temperatures and $\sim 0{\cdot}13$ eV for high temperatures. There appeared to be little or no influence of evaporation rate or thickness on the activation energies. A theory based on lattice defects is proposed in order to explain the electrical behaviour of the films. A.

537.311.33

7411. Irreversible changes of electron mobility in thin CdO layers. F. LAPPE. *Z. Phys.*, **137**, *No.* 3, 380–2 (1954) *In German.*

Measurements of resistivity and Hall coefficient on CdO cathode-sputtered layers from room temperature to 500°C. After heating to about 500°C, and cooling, the conductivity reverts to a higher room-temperature value than before heating. C. A. HOGARTH

537.311.33

7412. Experimental verification of the semiconducting characteristics of the compounds CdTe and In_2Te_3. J. APPEL. Note in *Z. Naturforsch.*, **9a**, 265–7 (*March*, 1954) *In German.*

The binding in CdTe is predominantly homopolar but in In_2Te_3 is heteropolar. Measurements of electrical conductivity on polycrystalline specimens were made from room temperature to 900°K (In_2Te_3) and to 1100°K (CdTe). Mean values for the activation energies (twice the log σ, $1/T$ slopes) were $0{\cdot}94$ eV (CdTe) and $2{\cdot}4$ eV (In_2Te_3). C. A. HOGARTH

537.311.33

7413. On the semiconducting properties of cuprous oxide. VIII. The electrical conductivity at 0°C as a function of the distance inside the specimen. C. FRITZSCHE. *Ann. Phys.* [*Leipzig*] **14**, *No.* 3–5, 135–40 (1954) *In German.*

It is shown that at 960°C specimens of Cu_2O prepared under different conditions of heat treatment have a surface layer with a lower electrical conductivity than the interior. Possible reasons for this are discussed. For Pt VI, see Abstr. 8402 (1953). C. A. HOGARTH

537.311.33 : 548.5

Recrystallation of germanium from indium solution. *See Abstr.* 7851

537.311.33 : 669.783 : 621.38

7414. Noise in germanium filaments at very low frequencies. B. V. ROLLIN AND I. M. TEMPLETON. Letter in *Proc. Phys. Soc.* [*London*] *B*, **67**, 271 (*March*, 1954).

The frequency dependence of current noise in 50 Ω cm Ge filaments is measured by the magnetic tape recording technique down to 4×10^{-4} c/s. The results confirm a law $\overline{\delta R^2}/R^2 \propto \delta f/f^{1\cdot35}$. Measurements at a.f. give a $-1{\cdot}3$ power law. C. A. HOGARTH

537.311.33 : 669.783 : 621.314.7

7415. Measurement of the surface properties of germanium. J. B. GUNN. *Proc. Phys. Soc.* [*London*] *B*, **67**, 409–21 (*May*, 1954).

New techniques are described for the measurement of the surface properties of *n*-type Ge. These make use of the properties of a new type of rectifying contact. Some preliminary results are given, which suggest the existence of a *p*-type surface layer separated from the interior of the specimen by a rectifying barrier. The observed properties of the surface layer do not support existing theories of rectification at a point contact, and are found to depend sensitively on surface condition. Two new types of transistor are described whose mechanism depends on the presence of the surface layer. A.

537.311.33

7416. Volume and surface recombination rates for injected carriers in germanium. J. P. MCKELVEY AND R. L. LONGINI. *J. appl. Phys.*, **25**, 634–41 (*May*, 1954).

A study of bulk minority carrier lifetimes and surface recombination rates has been made, using experimental equipment similar to that of Navon, Bray, and Fan, wherein the time-decay of carriers injected electrically by a pulse is observed. The diffusion theory for carriers of bulk lifetime τ has been worked out, considering a definite probability of nonrecombination, or reflection coefficient, to be associated with the surfaces of the sample. A simple

relationship between this quantity and the surface recombination velocity has been derived. If the surface recombination velocity is known, the effective trapping area at the surface may be calculated from this relation. Values of bulk lifetime and surface recombination velocity have been found for both *n*- and *p*-type germanium samples, and for a wide variety of surface treatments. By suitable modifications in experimental technique, this experiment may be utilized to measure drift mobility of minority carriers. A.

537.311.33

7417. Pressure dependence of the resistivity of germanium. W. Paul and H. Brooks. *Phys. Rev.*, **94**, 1128–33 (*June* 1, 1954).

The effect of hydrostatic pressure on the resistivity of a sample of 35 ohm-cm germanium has been investigated up to 30 000 kg/cm^2 pressure at temperatures between 25°C and 76°C, and up to 7000 kg/cm^2 pressure at temperatures down to −195°C. The results indicate an increase in the total energy gap to 15 000 kg/cm^2 at a rate in agreement with earlier experimental determinations at lower pressures. A rapid rise in resistivity above 15 000 kg/cm^2 that seems to apply to *n*-type germanium crystals of any purity has also been investigated. Explanations based on the deionization of impurities and on a decrease in electron mobility are discussed. A.

537.311.33 : 538.63

7418. Solution of the field problem of the germanium gyrator. R. F. Wick. *J. appl. Phys.*, **25**, 741–56 (*June*, 1954).

A mathematical solution is obtained of a two-dimensional boundary-value problem involving flow of electricity in a solid when Hall effect is present, it being assumed that only one type of carrier is involved and that there is no surface recombination. The solution is used to calculate the efficiency of a Hall-effect "gyrator," a four-terminal circuit element which violates the reciprocity law, as function of relative electrode size, shape of boundary, and magnetic field strength. It is also shown how corrections must be applied in measurements of Hall voltage and magneto-resistance in short samples. Some of the results have been checked experimentally with fields up to 22 000 gauss. The calculations have been carried out for much higher fields as well and should prove useful in studies of materials such as indium antimonide which have higher mobilities than germanium. A.

537.311.33 : 536.48

7419. The electrical properties of indium antimonide at low temperatures. J. Hatton and B. V. Rollin. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 385–6 (*April*, 1954).

Measurements have been made of the resistivity, the Hall coefficient and the magnetoresistance coefficients of indium antimonide over the temperature range 300°K to 1°K. A. E. de Barr

537.311.33

7420. The electrical conductivity of Fe_2O_3 with substituted TiO_2. H. Grunewald. *Ann. Phys.* [*Leipzig*] **14**, *No.* 3–5, 129–34 (1954) *In German.*

Measurements were made from 100 to 800°C on specimens containing up to 2 mol. % TiO_2. The conductivity rose steeply with increasing concentration and then flattened off. It is suggested that in the high-temperature region Fe_2O_3 may be an intrinsic semiconductor. C. A. Hogarth

537.311.33 : 539.234 : 548.7

7421. Electrical properties of single crystals and thin films of PbSe and PbTe. S. J. Silverman and H. Levinstein. *Phys. Rev.*, **94**, 871–6 (*May* 15, 1954).

A comparison was made of the electrical properties of single crystals and subsequently formed thin films of PbTe and PbSe. Hall constants and resistivities were measured as a function of temperature from 300° to 77°K. Films were formed and measured without exposure to air. Regardless of whether the original crystal was *n* or *p* type, all films were *n* type having carrier concentrations within the same order of magnitude for most cases. This observation was attributed to a limited amount of dissociation during evaporation, resulting in an inhomogeneous distribution of Te (or Se) agglomerates throughout the film. Room temperature mobilities in annealed films were about 1/5 that of the bulk values. In general carrier mobilities in films were markedly affected by substrate temperature during film formation, subsequent annealing, and limited oxygenation. A.

537.311.33

7422. Hall mobility of electrons and holes in silicon. P. P. Debye and T. Kohane. Letter in *Phys. Rev.*, **94**, 724–5 (*May* 1, 1954).

Results of measurements on single crystals indicate values of 1900 cm^2/volt. sec for electrons and 425 cm^2/volt. sec for holes for high purity material. The variation of mobility with resistivity agrees well with a theory due to Herring. C. A. Hogarth

537.311.33

7423. Avalanche breakdown in silicon. K. G. McKay. *Phys. Rev.*, **94**, 877–84 (*May* 15, 1954).

An avalanche theory of breakdown at room temperature is proposed for semiconductors based on the assumption of approximately equal ionization rates for electrons and positive holes. The problem of obtaining ionization rates from data obtained in inhomogeneous fields is solved exactly for two specific field distributions. Ionization rates for silicon thus calculated from experimental data on breakdown voltage and on prebreakdown multiplication for both linear-gradient and step junctions are in good agreement. The temperature coefficient of the ionization rate exhibits a similar internal consistency. It is concluded that internal field emission has not been observed in silicon. Detailed observations are reported of the pulse type noise associated with breakdown. It is shown that this noise represents the unstable onset of breakdown and that, for the junctions studied, all of the current flow in the breakdown region can be attributed to the current carried by the noise pulses. A.

537.311.33

7424. A preliminary study on the electrical properties of SnSe single crystals. Y. Matukura, T. Yamamoto and A. Okazaki. *Mem. Fac. Sci. Kyusyu Univ. B*, **1**, 98–101 (*March*, 1953).

Above room temp. SnSe single crystals are intrinsic

semiconductors. Measurements show that the conductivity increases only slowly with temp. in the range −150 to +250°C. The Hall coefficient, nearly constant near room temp., decreases to zero at 170°C, and then becomes negative. The conductivity perpendicular to the *c*-axis is apparently 30 times that parallel to the *c*-axis. J. H. MASON

537.311.33

7425. On the dependence of electrical conductivity of titanium dioxide on the content of ions of a different valency. H. GRUNEWALD. *Ann. Phys.* [*Leipzig*] **14,** *No.* 3–5, 121–8 (1954) *In German.*

The conductivity of TiO_2 is measured as a function of the molar concentration of small admixtures (up to 2%) of WO_3, Ga_2O_3, Al_2O_3, NiO, Cr_2O_3, at various temperatures. With addition of an oxide of higher valency (WO_3) the conductivity rises steeply. With lower valency oxides the conductivity falls slowly. The results are discussed in terms of the "Fehlordnung" theory. C. A. HOGARTH

537.311.33

7426. Extension of the theory of the junction transistor. E. S. RITTNER. *Phys. Rev.*, **94,** 1161–71 (*June* 1, 1954).

An examination of the validity range of the Shockley theory reveals that it is applicable to the emitter and collector regions for all current values of interest, whereas it is valid in the base region only for very small currents. In the present paper the treatment of the base region is extended so as to apply to arbitrary injection level and to include the effect of surface recombination. Two predictions are made: (*a*) the surface recombination velocity should increase with injection level; and (*b*) the α cut-off frequency for a transistor with plane parallel junctions should increase with emitter current by a factor of two. A.

537.311.33 : 621.3.012.8 : 621.314.7

7427. Electrolytic analog transistor. H. LETAW, JR AND J. BARDEEN. *J. appl. Phys.*, **25,** 600–6 (*May*, 1954).

This is an operating model of the junction transistor which substitutes the reduced and oxidized forms of ions in solution for electrons and holes in a semiconductor. A base electrode makes a low-resistance contact to the solution and also serves to maintain the ratio of oxidized and reduced ions at an equilibrium value, thus establishing the potential of the solution. In *P–N–P* operation, a polarizable metal electrode (the emitter) is held at such a potential above the base electrode that the majority ions, the reduced form, are readily oxidized at its surface. An identical electrode, the collector, is placed within a few tenths of a millimeter of the emitter. It is biased in such a way that the minority ions (the oxidized form) which diffuse from the emitter to its surface are reduced. Utilizing several oxidation-reduction couples and different base electrodes, it has been found that values of $\alpha = -(\partial I_c/\partial I_e)_{V_c}$ in the neighbourhood of unity can be obtained. Because of the relatively low mobilities of ions in solution, the device operates only at low frequencies. The device may also have some application as a constant current element in transistor bias circuits. A.

537.311.33 : 621.314.7

7428. Irradiation of transistors. C. D. FLORIDA, F. R. HOLT AND J. H. STEPHEN. Letter in *Nature* [*London*] **173,** 397–8 (*Feb.* 27, 1954).

Irradiation by neutrons reduces hole storage effects, apparently by reducing the hole lifetime. The effects are stable even after many temperature cycles to 70°C. C. A. HOGARTH

537.311.33 : 621.314.7

7429. A point emitter-junction collector transistor. R. H. KINGSTON. *J. appl. Phys.*, **25,** 513–15 (*April*, 1954).

A transistor structure utilizing a planar *p–n* junction as a collector, and a point contact as an emitter has been analysed theoretically and experimentally. The theory indicates that for maximum frequency cut-off the plane containing the emitter point should be nearly parallel to the collector junction. Also it is found that the base resistance is a critical function of the spacing between the emitter point and the collector junction. Results for experimental models are discussed. A.

537.311.4

7430. Remarks on the comparison between the study of an imperfect contact and the experimental results concerning thin metal films. N. NIFONTOFF. *C.R. Acad. Sci.* [*Paris*] **238,** 1200–2 (*March* 15, 1954) *In French.*

Discusses the theoretical interpretation of some experiments on the electrical resistance of imperfect contacts, and examines the possibility of regarding a granular metallic film as a group of imperfect contacts. P. M. DAVIDSON

537.311.4 : 621.315.5.066.6

7431. The growth of the liquid bridge in an electrical contact. P. M. DAVIDSON. *Brit. J. appl. Phys*, **5,** 189–91 (*May*, 1954).

Describes a mathematical method for calculating the progressive changes in the shape, size and temperature distribution of a molten contact-bridge, from the initial stage at which melting begins up to the final stage at which the bridge breaks. A.

537.311.62

7432. The theory of the anomalous skin effect in anisotropic metals. E. H. SONDHEIMER. *Proc. Roy. Soc. A*, **224,** 260–72 (*June* 22, 1954).

The theory of the anomalous skin effect in metals is extended to a uniaxial metal crystal containing two energy bands in each of which the energy surfaces are ellipsoids of revolution about the crystal axis. Explicit formulae are obtained, for the extreme anomalous limit, giving the dependence of the surface impedance on the orientation of the crystal axis, both for a plane metal surface and for a circular wire. The form of the anisotropy of the surface impedance is found to depend upon the axial ratios of the spheroidal energy surfaces and upon the ratio of the electron free paths in the two bands. Wide variations in behaviour are possible, and the surface impedance may show a high degree of anisotropy even when the d.c. conductivity is almost isotropic (as with tin at low temperatures). The results are evaluated numerically for tin, and the surface conductivity of a circular wire is found to show the minimum observed by Pippard [Abstr. 8755 (1950)]; the parameters can be chosen to give reasonable agreement with Pippard's results. A.

537.311.62

7433. The anomalous skin effect in anisotropic metals. A. B. PIPPARD. *Proc. Roy. Soc. A*, **224**, 273–82 (*June* 22, 1954).

It is shown that the theoretical form of the anisotropy of the high-frequency surface resistance of a metal having spheroidal energy surfaces, calculated exactly by Sondheimer (preceding abstract), may be obtained also in the extreme anomalous limit by means of the ineffectiveness concept. This result is taken to justify the application of the simpler ineffectiveness method to metals having Fermi surfaces of any form, and it is shown that the resistance is related solely to the geometrical shape of the Fermi surface. The possible application of this result in the study of metals is discussed. A.

537.311.62 : 535.137

7434. The anomalous skin effect and the reflectivity of metals. C. W. BENTHEM AND R. KRONIG. *Physica*, **20**, 293–300 (*May*, 1954).

It is shown that the standard theory of the skin effect and the reflectivity of metals is modified if the gas of conduction electrons is subject to internal friction. The energy dissipation resulting from this cause appears to furnish a contribution to the absorption factor of metallic conductors which can even become predominant at sufficiently low temperatures. In this respect the mechanism in question acts in the same sense as the effects, studied by Dingle [Abstr. 3486 (1954)], which arise from the mean free path of the conduction electrons for collisions with the lattice becoming comparable with the skin depth. In practice the two effects should be superposed. The agreement between theory and experiment is thereby improved. A.

537.312.5

7435. Silver bromide photocells. H. AMSLER. *Z. Elektrochem.* **57**, *No.* 9, 801–34 (1953) *In German.*

AgBr photocells with a barrier-photocell structure are obtained by brominating electrolytically a Ag sheet on one side and by depositing on the AgBr layer a transparent Ag film from vapour. When irradiated with monochromatic light (Hg lines) or with light of narrow spectral ranges, the cells yield a photocurrent. The deposited Ag electrode is the positive pole at stationary conditions. It has been found that the electric resistance of the cell does not depend on the intensity of irradiation. The short-circuit current, while practically independent of inner resistance, is exactly proportional to intensity of irradiation. Determination of the quantum yield for the practically totally absorbed radiation $\lambda 365$ mμ has shown that the quantum yield depends on the thickness of the deposited Ag electrode, attaining the value of 1 in favourable circumstances. The spectral distribution of the light yield of the cell is comparable to that of the sensitivity of photographic emulsions. A certain time is required until the stationary photo-potential is reached. F. LACHMAN

537.312.5

7436. Influence of the addition of another element on the characteristic of a Cs–Sb photocathode. N. SCHAETTI. *Z. angew. Math. Phys.*, **4**, *No.* 6, 450–9 (1953) *In German.*

Investigations on the dark current in photomultipliers with Cs–Sb and Li–Sb photocathodes indicate that these cathodes show a delayed emission of electrons after each exposure to light. The addition of certain elements to the cathode layer reduces this delayed emission and at the same time the dark current of the photocathode. A.

537.312.5

7437. The photo-voltaic effect of selenium photocells. Y. MATUKURA AND A. OKAZAKI. *Mem. Fac. Sci. Kyusyu Univ. B*, **1**, 89–93 (*March*, 1953).

The dependence of photocurrent and voltage of selenium rectifiers and photocells is measured with temperature, bias voltage and light intensity as variables, and the results agree well with theoretical equations derived by Lehovec (1948). C. A. HOGARTH

537.312.5

7438. The photodianode: study of total current and differential current in a di-symmetric system. L. DELOFFRE, E. PIERRE AND J. ROIG. *C.R. Acad. Sci. [Paris]* **238**, 1213–15 (*March* 15, 1954) *In French.*

537.312.5

7439. Organic photoconductors. I. The kinetics of photoconductivity in Rhodamine B. R. C. NELSON. *J. chem. Phys.*, **22**, 885–9 (*May*, 1954).

The behaviour of Rhodamine B undergoes a change at about 60°c, below which temperature it is complicated by memory effects. Above 60°c the decay process is strictly bimolecular. Three activation energies were measured: for conduction, for decay, and for rise of conductivity, and each was approximately 0·55 eV. The observed second-order character and the absolute rate of the decay process can be accounted for by a model having a large density of mono-energetic traps lying 0·55 eV below the conduction band. There is evidence that the slowness of reaching a steady state in light is to be associated with a redistribution of charge carriers from the random sites in which they are formed into preferred sites or configurations. A.

537.312.5

7440. Organic photoconductors. II. Crystal violet. R. C. NELSON. *J. chem. Phys.*, **22**, 890–2 (*May*, 1954).

Photoconductivity in crystal violet is a volume effect primarily, and surface or electrode complications have not been recognized. Donor and trapping impurities may be introduced into films, but the highly purified substance shows a large photoconductivity. The thermoelectric effect is normal. On the other hand, rates are extremely slow, there is a prominent long-lived memory effect, and under certain circumstances the second-order rate constant for a particular decay process is inversely proportional to the initial conductance. A hypothesis is proposed to account for the last-mentioned peculiarity, in terms of which structures are formed in the film which have the property of maintaining a constant initial density of charge carriers, the steady-state conductance being no longer a measure of their density but only of their total number. A.

537.312.5

7441. Organic photoconductors. III. The kinetics of basic fuchsin. R. C. NELSON. *J. chem. Phys.*, **22**, 892–5 (*May*, 1954).

To account for the influence of temperature on

rates and levels of conductance in basic fuchsin, two activation energies are required; for diffusivity, and for quantum yield of charge carriers, and these are approximately equal, having a value near 0·38 eV. Two régimes of behaviour with respect to light intensity are found, one in which the response is proportional to the illumination, and another, which may be established by strong pre-illumination of the film, in which the response is as the square root of the light intensity. These observations are in accord with the hypothesis which was proposed to account for the inverse dependence of rate constant on initial conductance in crystal violet. A.

537.312.5 : 537.311.33

7442. Photo- and semi-conductance in molecular single crystals. D. J. Carswell, J. Ferguson and L. E. Lyons. Letter in *Nature* [*London*] **173,** 736 (*April* 17, 1954).

The photoconductive spectral response of anthracene-type crystals correlates with the absorption bands and semiconduction activation energies with known electronic transitions in the vapour phase for excitation to the triplet level. G. F. J. GARLICK

537.312.5 : 537.58 : 548.7

7443. Thermionic emission and photoelectric emission of sodium chloride. A. Bohun. Letter in *Czech. J. Phys.*, **4,** 91–3 (*Feb.*, 1954) *In German.*

The thermionic and photoelectric emission characteristics of NaCl coloured by X-rays were measured and an attempt is made to relate the maxima of the spectral response of photo-emission and the maxima of the thermionic-emission *v.* temperature curves to the various types of colour centres in NaCl.

G. F. J. GARLICK

537.312.5 : 538.65

7444. On the theory of the photo–magneto–mechanical effect. P. Aigrain and O. Garreta. *C.R. Acad. Sci.* [*Paris*] **238,** 1573–5 (*April* 12, 1954) *In French.*

An equation is given for the photodiamagnetic force expected in a semiconductor on the basis of a prediction by Aigrain and Bulliard [Abstr. 4812 (1953)]. A new effect analogous to the photo–magneto–electric effect is predicted and its expected magnitude calculated. C. A. HOGARTH

537.312.5 : 621.383.27

7445. A method of testing the linearity of response of photomultipliers under pulsed conditions. W. T. Link and D. Walker. Letter in *J. sci. Instrum.*, **31,** 110 (*March*, 1954).

A c.r.t. beam is modulated (on/off) by 2 μsec pulses applied to its grid and the output light pulses passed through a calibrated neutral wedge filter to provide light pulses of known relative intensity for testing the linearity of a photomultiplier.

G. F. J. GARLICK

537.312.5 : 621.383.27

7446. The application of RCA 1P28 photomultiplier tubes to the detection of weak light intensities. F. Boeschoten, J. M. W. Milatz and C. Smit. *Physica*, **20,** 139–56 (*March*, 1954).

Two methods are discussed of measuring weak light intensities (varying only slowly with time) with the aid of a photomultiplier tube: (1) the light-chopping method, in combination with a phase- and frequency-sensitive measuring device (i.e. a.c. galvanometer); (2) the counting method, as used, for instance, in scintillation counters. In particular, the factors determining the detection limit and the reproducibility of these methods are investigated, namely, the internal amplification factor, the quantum efficiency and the dark current of the photomultiplier. These factors were found to vary among ten RCA 1P28 tubes operating under the same condition, with an average spread of about two and an extreme spread of ten times. The output-current generated by a light flux of constant intensity was constant in time within 1% (the error of measurement) when a well stabilized high voltage source is used. The dark current, however, varies very irregularly with time. The noise of the photo- and dark-current measured within a narrow band about 50 c/s appeared to exceed the calculated value by a factor 2–3, which may be due to the flicker effect. The optimum operation conditions for measuring weak intensities were found to be obtainable with an uniform voltage drop amounting to 60–70 V over each stage. The effect of decreasing the thermionic current (the most important component of the dark-current) by cooling the tube with liquid air, on the useful sensitivity was investigated as also was the alteration of the spectral response curve as a function of the temperature. A.

537.312.62

7447. Isotope shift of the temperature of transition of Tl into the superconductivity state. N. E. Alekseevskiĭ. Letter in *Zh. eksper. teor. Fiz.*, **24,** *No.* 2, 240–1 (1953) *In Russian.*

Presents the results of tests on two specimens of Tl, with atomic masses of 203·34 and 204·94. The transition temperatures obtained are $2{\cdot}403 \pm 0{\cdot}003$ and $2{\cdot}392 \pm 0{\cdot}003$°K, respectively. Tl is, so far, the only pure metal with a positive $\partial T_c/\partial\rho$.

F. LACHMAN

537.312.62

7448. The effect of hydrostatic pressure on the superconducting transition of tin and thallium. M. D. Fiske. Letter in *Phys. Rev.*, **94,** 495 (*April* 15, 1954).

$\Delta T_c/\Delta P \times 10^5 = -4{\cdot}9 \pm 0{\cdot}5$ deg/atm for Sn and $+1{\cdot}3 \pm 0{\cdot}2$ deg/atm for Tl for pressures <115 and <48 atm respectively. See also Abstr. 474 (1954).

H. LONDON

537.312.62

7449. Theory of boundary effects of superconductors. J. Bardeen. *Phys. Rev.*, **94,** 554–63 (*May* 1, 1954).

An extension of the phenomenological London equations to take into account a space variation of the concentration of superconducting electrons is presented. The theory differs from that of Ginsburg and Landau in that it makes use of the Gorter–Casimir two-fluid model rather than an order parameter to derive an expression for the free energy. An effective wave function is used for the superconducting electrons. The theory is applied to calculate the boundary energy between normal and superconducting phases and the relative change $\Delta\lambda/\lambda$ of penetration depth with magnetic field. Calculated values of

boundary energies are somewhat larger, and of $\Delta\lambda/\lambda$ somewhat smaller, than observed. It is suggested that additional nonlinear terms are required to account for the observed $\Delta\lambda/\lambda$ at low temperatures. The connection of the theory with Pippard's ideas on range of order is discussed briefly. A.

537.312.62 : 548.736.1

Superconductivity of lanthanum. *See Abstr.* 7881

537.312.8

7450. Magneto-resistance of copper to 150 000 oersted at 4·2°K. J. L. Olsen and L. Rinderer. Letter in *Nature* [*London*] **173,** 682 (*April* 10, 1954).

Measurement of both transverse and longitudinal effect in magnetic fields produced by Kapitza's method. E. H. SONDHEIMER

537.312.8 : 548.0

7451. Variation of the electric resistance of crystals of transformer steel in a magnetic field. T. D. Zotov and Ya. S. Shur. *Dokl. Akad. Nauk SSSR*, **86,** *No.* 2, 267–9 (1952) *In Russian.*

537.32 : 536.48 : 539.11

7452. Anomalous electron-scattering in metals. D. K. C. MacDonald and W. B. Pearson. *Phil. Mag.*, **45,** 491–6 (*May*, 1954).

A semi-theoretical equation was proposed previously [Abstr. 7690 (1953)] to account qualitatively for the thermoelectric power of metals and alloys, particularly at low temperatures. The consequences of this equation are now examined quantitatively in relation to experimental data on alloys of copper. A.

537.322

7453. Seebeck effect in germanium. T. H. Geballe and G. W. Hull. *Phys. Rev.*, **94,** 1134–40 (*June* 1, 1954).

An apparatus for making measurements of the Seebeck effect between 20°K and 375°K is described. Experimental curves of the Seebeck effect are given for a series of germanium crystals in which various concentrations of acceptor and donor atoms have been incorporated. The Seeback data are compared with Hall data obtained concurrently. Above 250°K the two effects can be correlated by means of existing theory. Below 250°K a marked discrepancy occurs between existing theory and experiment. The temperature dependence of this discrepancy and its dependence upon concentration of added atoms are given. The results are consistent with a new theory proposed by C. Herring which considers an interaction between the phonon and electron systems. A dependence of Seebeck voltage upon sample dimension which is predicted by Herring's theory has been found in the temperature region below 50°K. A value of $(0{\cdot}75 \pm 0{\cdot}2)m$ has been determined for the mass parameter of both holes and electrons which enters into the "density of states" equation. A.

537.324

7454. Thermocells with solid and fused electrolyte. H. Holtan, Jr. *Proc. K. Ned. Akad. Wetensch. B*, **56,** 498–509 (*Nov.–Dec.*, 1953).

The part of the thermopotential containing only thermostatic functions and transference numbers has been calculated for a number of thermocells with solid electrolyte and compared with experimental results. It is remarkable that the calculated values agree with the experimental ones within the limits of error in most cases, which means that the part of the thermopotential containing entropies of transfer is negligible in these cells. The conventional transference numbers for solid salts are not always identical with the transference numbers as defined in the thermodynamical theory of irreversible processes. This fact has been taken into account. A.

537.324

7455. Thermocells containing electrolytic solutions. H. Holtan, Jr. *Proc. K. Ned. Akad. Wetensch. B*, **56,** 510–14 (*Nov.–Dec.*, 1953).

The expression for the thermopotential in pure thermocells can be split into a "kinetic" and a "thermostatic" part. For thermocells with solid salts the "thermostatic" part agrees in most cases with the experimental thermopotential. This shows that the kinetic part is negligible in these cells. In the present paper the "thermostatic" part is calculated for thermocells with electrolytic solutions. An accurate calculation of this term is not possible as the amount of solvent transported by an electrical current through the solution has not been determined accurately enough. No definite conclusions can be drawn, therefore, as to the contribution of the first part of the expression to the thermopotential. However, roughly the same trend is found in the results calculated as in the experimental results when variations of concentration and solutions of different chlorides are considered. This would not have been found if the solvation of the ions had been neglected as has been done in earlier treatments of the thermopotential for cells containing electrolytic solutions. A.

537.324

7456. The relation between the temperature coefficient of isothermal cells and the thermopotentials of the corresponding thermocells. H. Holtan, Jr. *Proc. K. Ned. Akad. Wetensch. B*, **57,** 138–41 (*Jan.–Feb.*, 1954).

Reinhold found experimentally that there is a correspondence between the temperature coefficient of an isothermal cell and the thermopotentials of the corresponding thermocells when the electrolyte is a solid salt. The exact relation is derived here and it is shown that the correspondence is actually only approximate. A similar correspondence between isothermal cells and corresponding thermocells is shown to be valid also for thermocells containing electrolytic solutions. A.

537.324 : 621.311.25 : 621.362

7457. Solar thermoelectric generators. M. Telkes. *J. appl. Phys.*, **25,** 765–77 (*June*, 1954).

The physical characteristics, thermoelectric power, resistivity, specific heat conductivity and the temperature difference between hot and cold junctions determine the efficiency of thermocouple materials. These data have been determined for Chromel *P*-constantan, bismuth alloys and the intermetallic compound ZnSb, containing small amounts of added metals. The optimum characteristics of flat-plate type solar energy collectors have been evaluated in combination

with thermocouples, designed for maximum energy conversion. Using flat-plate collectors with 2 glass panes, an efficiency of 0·63% was obtained with the ZnSb-type alloys in combination with a negative Bi-alloy. The commercially available ductile alloys Chromel *P*-constantan, produced ten times lower efficiency. Calculations indicate that the efficiency may be increased to 1·05% by using 4 panes of low-reflection characteristics. With solar energy concentrating means (lenses), the efficiency was increased to 3·35%, using the above mentioned best alloy combination. The maximum allowable cost of thermoelectric generators has been evaluated, by comparison with present methods of electric power generation. Solar thermoelectric generators may find useful application in the tropics, as they do not contain moving parts and require very little attention. Further development is needed to determine their economical value. A.

537.362

7458. The phenomenology of electro-osmosis and streaming potential. P. B. LORENZ. *J. phys. Chem.*, **56**, 775–8 (*June*, 1952).

All electrokinetic processes in a porous solid can be compactly described by two equations, with the four variables current, flow, pressure and voltage. Only three parameters are necessary: electrical conductance, permeability and the newly-defined *electropermeability*. Electropermeability can be expressed in terms of the "ζ-potential" but this is of doubtful value in electrokinetics. The three parameters are not completely independent, but are subject to the restriction that a certain quotient must be less than 1. The same quotient is an explicit expression for the electroviscous effect, and an analogous *electro-osmotic conductance effect*. Electrical conductance and permeability vary somewhat, and surface conductance can have very different values, depending on the conditions of measurement. A.

537.362

7459. Influence of moisture conductivity during electro-osmosis. A. V. NETUSHIL AND K. M. POLIVANOV. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 5, 845–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-120.

The dependence on time of the velocity of motion at the cathode of the moisture in soil placed in an electric field between two perforated electrodes is theoretically investigated for the case in which there is no motion at the anode. W. GOOD

537.364 : 541.183

7460. Experimental study of surface potential analysis. I. Apparatus and method of measurement. S. KOGA. *J. Sci. Res. Inst.* [*Tokyo*] **47**, 172–80 (*Dec.*, 1953).

A set-up for the measurement of surface potentials using a vibrating dynamic condenser as the detecting element is described, and three types of transducer are shown, in one of which modulation is effected with a resonant reed, and in the other two by a normal free-edge plane. Measurements with the electrical circuits described can be made, both on liquid and solid surfaces, to within ± 1 mV. R. C. MURRAY

537.364 : 541.183

7461. Experimental study of surface potential analysis. II. Metals and semi-conductors. S. KOGA. *J. Sci. Res. Inst.* [*Tokyo*] **47**, 181–8 (*Dec.*, 1953).

The method previously described (previous abstract) has been applied to the measurement of the Volta potentials of various pure metals and binary alloys, the surface potential change during the oxidation of aluminium, copper, and zinc, the study of the potential profile of a Cu–Zn–Ni alloy as a means of determining the thickness of the Zn-poor surface layer formed by evaporation of Zn during heat treatment, the determination of the structure of selenium rectifiers, leading to identification of a stoichiometric selenide as the blocking layer, and the photo-reduction of silver bromide. R. C. MURRAY

537.364 : 541.183

7462. Experimental study of surface potential analysis. III. Physical adsorption of water vapour. S. KOGA. *J. Sci. Res. Inst.* [*Tokyo*] **47**, 189–95 (*Dec.*, 1953).

The surface potential on a piece of rolled platinum plate, preheated to various temperatures, was measured at various relative humidities, and the curves obtained analysed on the assumption of physical adsorption of water molecules as oriented dipoles, on oxygen atoms chemisorbed on the Pt, and indicates a value of 6×10^{-19} e.s.u. for the dipole moment of the oriented water molecules. This suggested that each water molecule fits on to the surface layer of chemisorbed oxygen atoms using one H atom to bridge with the nearest O atom, leaving the other one unbonded, so that the dipole moment should be 10×10^{-19} e.s.u. The reasons for the deviation between this and the measured value are discussed. R. C. MURRAY

537.364 : 541.183

7463. Experimental study of surface potential analysis. IV. Potential analysis of organic molecules. S. KOGA. *J. Sci. Res. Inst.* [*Tokyo*] **47**, 196–201 (*Dec.*, 1953).

Measurements of surface potentials of fatty alcohols and fatty acids on various metals, previously heated to produce an oxidized surface, indicate that: (*a*) the disorientation temperatures of fatty alcohols on metal differ from their bulk phase m.pt.'s, (*b*) thin films of fatty acids on most metals show two characteristic disorientation temperatures, corresponding to the m.pt's of the free acids and the metallic soaps, respectively, (*c*) there is a second-order phase transformation in an adsorbed film of cetyl alcohol, whose nature is discussed in detail. Surface potentials for the adsorption of palmitic acid, cetyl alcohol, monocetyl and tricresyl phosphates from various concentrations in benzene were measured, and compared with measurements of kinetic friction coefficient for the same solutions, for severe boundary lubrication. Finally, surface potentials of an AgBr surface on to which a sensitizing dye had been adsorbed, were measured as a function of the concentration of the dye solution from which adsorption took place, and indicate, in agreement with results of other published work, that mono- and dimolecular saturated adsorption can be reached. R. C. MURRAY

ELECTRIC DISCHARGES 537.52

537.523.4

7464. Notes on secondary energy processes in spark discharges. B. H. ZÍTKA AND K. ŠOBRA. Letter in *Czech. J. Phys.*, **3**, 171–4 (*June*, 1953) *In Russian.*

The effect of an insulator with a small (0·4–1·0 mm dia.) channel placed between discharge electrodes (500 V, 500 μF) is investigated. As the insulator thickness is increased from 0 to 4 mm the maximum current falls, but the spark is lengthened so that currents $\sim$200 μsec after the discharge are greater than at a similar time without the insulator. The loss of weight per spark of the electrodes is a maximum with insulator thicknesses 2–8 mm.

D. H. WHIFFEN

537.523.4 : 535.33.03

The afterglow spectrum of long sparks in air. *See Abstr.* 7262

537.525 : 536.5 : 621.372.413 : 621.3.014.31

7465. Measurements of the gas temperature of a low-pressure r.f. discharge. I. REINGOLD AND K. GAROFF. *J. appl. Phys.*, **25**, 537–40 (*April*, 1954).

An experimental investigation of the manner in which the gas temperature resulting from an r.f. sheath discharge is affected by the incident line power, gas fill and Q of the cavity in which it is confined. Data are presented of the measured gas temperature as a function of line power for cavities of different Q. Qualitative results are submitted of the effectiveness of the gas and of the cavity in dissipating the heat resulting from the power absorbed by the cavity. Argon, hydrogen, nitrogen and argon and water vapour were the gas fills investigated. A.

537.525.3

7466. Fast time analysis of intermittent point-to-plane corona in air. III. The negative point Trichel pulse corona. M. R. AMIN. *J. appl. Phys.*, **25**, 627–33 (*May*, 1954].

For Pt II, see Abstr. 6637 (1954). Fast oscilloscopic time analysis of the negative point Trichel pulse corona in room air at various pressures and gap geometries reveals the following data. The very short rise and quenching time of the pulse at atmospheric pressure observed by English is confirmed. Under these conditions the secondary action is a photoelectric liberation from the cathode and discharge extinguishes by dissociative attachment to give O^- ions. Decreasing pressures reduces space charge density, prolongs the discharge and brings in a secondary liberation by positive ion bombardment. Increasing potential at constant pressure at first decreases clearing time, leaving pulses unchanged and current increases proportional to repeat rate. At higher potentials, photon action is reduced relative to positive ion impact at the cathode, the discharge extends farther into the gap, and quenching is very effective with less total ions reducing pulse size. With increasing repeat rate, current no longer increases proportional to repeat rate in consequence of smaller pulse height. The effects of increased point diameter are increased pulse size. Comparable clearing times for large and small points require higher potentials for the former. Thus, at constant pressure and potential, increase in point radius produces a decrease in frequency and increase in total charge per pulse. Conditioning of the point at high-current densities and repeat rates decreases the number of ions per pulse, which is of the order of 10^9 under normal circumstances, and shortens the pulse by reducing cathode work function and increasing photoelectric liberation, so that choking occurs with little ion action. Since repeat rate is slightly decreased by the charge liberation, the reduced pulse charge yields a reduced current through a conditioning that decreases work function. Comparison of ion movement across the gap during clearing time, with that for O_2^+ ions of known mobility in air, indicates that the rapid ion transit in Trichel pulses is caused by a majority of O^- ions with a mobility of about 4 cm^2/volts sec from near the cathode with some formation of O_2^- ions in transit. A.

537.525.8

7467. The saturation in the negative Joshi effect with respect to the light intensity as the consequence of the negative space charge responsible for the effect. S. R. MOHANTY. *J. phys. Chem.*, **58**, 178–9 (*Feb.*, 1954).

The tendency to saturation in the negative Joshi effect $-\Delta i$ with respect to the light intensity I is the consequence of decrease in the quantum efficiency of the photoelectronic emission process due to increase in the negative space charge density. This last remains constant when the area of the electrode surface irradiated S_L, at a given I, is varied; the space charge sheath is, however, enlarged in extent proportional to S_L. The observed linear increase in $-\Delta i$ with S_L follows. The change in $d(-\Delta i)dS_L$ with variation in (the nature of) the electrode surface shows conclusively that the latter is of primary significance for the occurrence of the Joshi effect. A.

537.525.8

7468. A study of the starting of electrodeless discharges in neon and xenon. F. CABANNES. *C.R. Acad. Sci.* [*Paris*] **238**, 1482–4 (*April* 5, 1954) *In French.*

Gives exptl. data for 750 kc/s, and 1·1 and 2·9 Mc/s for pressures varying from about 5×10^{-2} to 4 mm Hg pressure, with a brief discussion.

J. D. CRAGGS

537.525.8

7469. The hollow-cathode effect and the theory of glow discharges. P. F. LITTLE AND A. VON ENGEL. *Proc. Roy. Soc. A*, **224**, 209–27 (*June* 22, 1954).

By exploring the electric field between two plane-parallel cathodes with an electron beam, and observing simultaneously the other discharge parameters, new information was obtained. A double (hollow) cathode was used because in a conventional glow discharge the dark space, cathode fall and current density are interdependent; here the cathode separation controls the width of the dark space. When the separation is sufficiently reduced the two negative glows coalesce and the light emitted as well as the cathode current density rise greatly. This is

the hollow-cathode effect. Results show that the field in the two dark spaces of a hollow cathode falls linearly with the distance from the cathode, and thus the net space-charge density is constant, as it is known to be in the conventional discharge. From the same observations the dark-space length is found. The conclusions drawn from these results lead to an elementary theory, which covers both the hollow and the conventional glow discharge in various gases since with increasing cathode separation the first goes over into the second type. The main feature is the contribution of the ultraviolet quanta from the glow to the photoelectric emission from the cathodes which is regarded as the essential factor in secondary electron emission. Another result comes from a reconsideration of the motion of positive ions in the dark space based on atomic beam studies and the modern theory of elastic collisions between ions and atoms. The discrepancy between earlier experiments showing that ions of energy of the order of the cathode fall in potential arrive at the cathode and classical calculations leading to low ion energies is resolved by allowing for small-angle scattering and charge transfer. A.

537.525.8

7470. Theory of the positive column. G. ECKER. *Proc. Phys. Soc.* [*London*] *B*, **67**, 485–91 (*June*, 1954).

Experiments have shown that when the current through a positive column in mercury vapour falls below a certain limit, the longitudinal field does not remain constant, but increases with decreasing current, at first slowly and later more rapidly. This is due principally to failure of the discharge to establish a plasma with approximately equal concentrations of ions and electrons. The properties of the positive column have been formulated without making any initial assumption about the concentrations. A complicated system of differential equations with boundary conditions results, which determines the concentration of the charged particles, and hence all the other properties of the discharge. Schottky's theory of the quasineutral column appears as a limiting case. To obtain a preliminary solution of the equations, which need normally mechanical integration, the assumption has been made that, to a first approximation, the concentrations are in a constant ratio. The equations can then be solved, and in particular expressions obtained for the current v. longitudinal field characteristic curve for the column, and for the onset conditions for the special properties of the low-current form of the column. Fairly good agreement has been found between the numerical predictions of the theory and the results of experiment. It has also been found that with decreasing current density the field approaches a limiting value which is obtained from the usual Schottky formula simply by replacing the ambipolar diffusion coefficient by the electron diffusion coefficient. A.

537.525.8 : 538.561 : 538.566

7471. Electromagnetic properties of plasmas in a magnetic field. M. BAYET. *J. Phys. Radium*, **15**, 258–63 (*April*, 1954) *In French.*

A theoretical paper dealing with transport equations in low-pressure discharges. Subjects discussed include the mobility and diffusion coefficients for electrons, the propagation of plane electromagnetic waves in the plasma and (more briefly) plasma oscillations.

J. D. CRAGGS

537.525.8 : 541.135

7472. On glow discharge electrolysis with alternating current. F. BRANDSTAETTER. *Z. angew. Phys.*, **6**, *No.* 4, 164–8 (1954) *In German.*

A general discussion of effects arising in electrolysis in the presence of a glow discharge; the electrolyte forms one of the electrodes. Rectifying action is demonstrated by following the relation between the a.c. and d.c. components of current. J. D. CRAGGS

537.527.5 : 538.69

7473. Motion of arc cathode spot in a magnetic field. R. M. ST. JOHN AND J. G. WINANS. *Phys. Rev.*, **94**, 1097–102 (*June* 1, 1954).

The motion of the cathode spot of a mercury arc was observed under various transverse magnetic fields, arc currents and inert gas pressures. With no inert gas, the retrograde velocity increased as the magnetic field strength increased. Addition of an inert gas at low pressures reduced the retrograde velocity and at higher pressures caused a forward (direction of magnetic force) motion. The motion of the cathode spot in a magnetic field can be associated with electrostatic forces on positive ions produced by electron impact. A cathode spot assembly consisting of a group of electrons in the cathode, a positive ion sheath separated by a dark space from the cathode, and an electron cloud between the positive ion sheath and anode is postulated. Electrons after acceleration through the cathode dark space would travel a curved path due to the magnetic field and produce new positive ions on the forward side of the cathode spot. These new positive ions would be attracted by the cathode spot assembly with a resultant force that would cause them to overshoot the positive ion sheath before being pulled into the cathode to start a new spot in the retrograde direction. Addition of an inert gas reduces the mobility of positive ions to the order of that of the cathode electrons thus permitting forward motion of the cathode spot assembly to reduce the overshooting. Higher pressures would cause a forward spot motion. A.

X-RAYS 537.531

537.531 : 535.3

7474. The regularity of the X-ray spectra of light elements. I. J. BAČKOVSKÝ. *Czech. J. Phys.*, **3**, 137–50 (*June*, 1953) *In German.*

Data have been collected from many authors for elements Li^3 to Ne^{10}; the wavelength range is from 14·6 to 228 Å. A relation $\sqrt{(\nu/R)} = rZ - s$ is deduced, where $r = 0{\cdot}8441$, $s = 0{\cdot}538$. A. R. STOKES

537.531 : 535.33.07

7475. A linear motion X-ray spectrometer. H. P. HANSON AND H. W. SCHRADER. *Rev. sci. Instrum.*, **25**, 422–3 (*May*, 1954).

A single-crystal X-ray spectrometer has been constructed in which the change in Bragg angle is effected

through a linear rather than angular motion of the crystal. In certain measurement problems this design offers advantages over the conventional type from a standpoint of versatility and ease of alignment. A.

537.531 : 535.338

7476. The satellites of the $K\beta_1$, β_5 lines and the fine structure of the K absorption edge of copper. T. HAYASI. *Sci. Rep. Tôhoku Univ. First Ser.*, **36**, 225–35 (*Dec.*, 1952) *In German.*

An investigation of the satellites of the $K\beta_1$, β_5 lines of Cu and the structure of the K absorption edge of metallic Cu by microphotometric investigation of photographic records from a focusing spectrograph. It is shown that both lines consist of about five components, and that the short wavelength absorption edge is itself complex. An emission line β_{IV}, of shorter wavelength than the main absorption edge region, was found. A. E. DE BARR

537.531 : 535.338

7477. X-ray radiation excited by protons. Č. SIMÁNĚ. Letter in *Czech. J. Phys.*, **3**, 175 (*June*, 1953).

When a copper target was bombarded with 750 keV protons, the $K\alpha_1$ line of the characteristic X-ray spectrum of copper was observed by means of a simple Bragg spectrometer using an NaCl crystal and G.M. counters. The dependence of the quality and intensity of the X-radiation from different target materials previously found by Livingstone *et al.* has been confirmed. D. R. CHICK

537.531 : 535.34 : 548.732

Absorption of X-rays by quartz crystals near the Bragg angle. *See Abstr.* 7868

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 621.384.611

7478. Microtrons (electron cyclotrons) for X and K band operation. H. F. KAISER. *J. Franklin Inst.*, **257**, 89–108 (*Feb.*, 1954).

Certain desirable features of the microtron favour its development as a compact, high-energy particle accelerator. When scaled for use at higher frequencies increased compactness results. This article describes two X-band (10^{10} c/s) microtrons which have been built and successfully operated and gives the experimental data on their operation. The principles involved in scaling the microtron for X and K-band ($2{\cdot}5\times10^{10}$ c/s) frequencies are discussed. A.

537.533 : 621.384.612

7479. Design study of a strong-focusing electron-synchrotron. E. SMÅRS AND O. WERNHOLM. *Ark. Fys.*, **7**, *Paper* 38, 463–72 (1954).

Material costs can be reduced by strong-focusing, but increased precision is required in magnet alignment. The electron machine is in many respects simpler than that for protons, and could be envisaged as a model to test the focusing properties of the latter. The theory of Lundquist [Abstr. 8456 (1953)] is reviewed. Testative designs are given for 500 and 1000 MeV machines. The field index n is kept down to 11·4 and 24·3 to relax tolerances. Initial betatron acceleration is to an energy at which frequency modulation is unnecessary and which is higher than what would have been the critical energy for phase-stability. J. S. BELL

537.533.3 : 518.5 : 621.317.729 : 621.317.32

7480. Automatic electron trajectory plotting using the electrolytic tank analogue. B. O. BAKER. *Brit. J. appl. Phys.*, **5**, 191–5 (*May*, 1954).

Equipment is described for the automatic plotting of electron trajectories with the electrolytic tank analogue. It has been found that the results in a known system are within 2% of the correct solution. The method is applicable to electron optical problems in two or three dimensions. The tank has also been used to solve a variety of problems involving Laplace's equation to an accuracy of better than 1%. A.

537.533.3 : 621.385.833

7481. On the chromatic aberration of electron lenses. H. GRÜMM. *Ann. Phys.* [*Leipzig*] **14**, *No.* 3–5, 193–200 (1954) *In German.*

The chromatic aberration of electron lenses is investigated by the methods of wave mechanics [Glaser and Schiske, Abstr. 2481–2 (1954)]. In this way it is possible to evaluate the intensity distribution in the image, which cannot be done in geometrical optics. As in the latter method, certain simplifications are introduced in order to obtain results of practical significance. The case of a simple amplitude object is taken (circular hole) and expressions are obtained for the "first" chromatic coefficient, relating to the shift of the image plane, and the "second" coefficient relating to the change in magnification. It is shown that in the ideal case correction can be obtained, since the coefficients are of opposite sign. In the practical case of a bell-shaped magnetic field, the compensation is not perfect but has a minimum when the lens strength parameter $k^2 = 1$. It is concluded that previous estimates of the chromatic aberration have been too pessimistic. V. E. COSSLETT

537.533.3 : 621.384.62

7482. Transverse motion of an electron in a constant wave speed section of a linear accelerator. I. JACOBS AND E. S. AKELEY. *J. appl. Phys.*, **25**, 572–6 (*May*, 1954).

The relativistic differential equations of motion of an electron in the field of a linear accelerator are considered. Treating only electrons near the axis the field components are expanded in powers of distance from the axis r, and terms in r and $\dot{r}$ of order two higher than the lowest order terms are neglected. The first integrals of two of the equations of motion are then obtained, and together with the equation of motion for the r co-ordinate, give a second-order nonlinear differential equation for r as a function of the phase of the electron with respect to the peak of the accelerating electric field. Utilizing earlier results giving the dependence of phase on distance along the axis of the accelerator, a choice of a particular d.c. magnetic focusing field allows this differential equation to be integrated twice, from which r as a function of distance along the accelerator is plotted. The need for a focusing field is indicated,

and it is shown that the particular field chosen has the advantage that with it, the electron will oscillate between known fixed limits of r. The necessity of shielding the electron emitter from the focusing field is shown, and an indication of the magnitude of the field and length of the accelerator for which it should be used, is given for the Purdue accelerator. A.

537.533.331 : 621.385.833

7483. Calculation of the axial potential of a three-electrode electrostatic lens. P. EHINGER. *C.R. Acad. Sci.* [*Paris*] **238**, 1306–8 (*March* 22, 1954) *In French.*

By a modification of a method of Bernard [Abstr. 6660 (1954)], expressions are derived for the axial potential of an electrostatic three-electrode lens. The theory requires the electrodes to be in the form of long cylinders, but an experimental check shows that the expressions hold also for the case of a thin central electrode. A.E.I. RESEARCH LABORATORY

537.533.331 : 621.385.833

7484. Potential distribution of symmetrical cylindrical electron lenses. G. D. ARCHARD. *Brit. J. appl. Phys.*, **5**, 179–81 (*May*, 1952).

Expressions are developed for the distribution of axial potential and potential derivatives in the two-dimensional "unipotential" electron lens. Comparison is made with expressions obtained in simpler cases, and an example is illustrated. A.

537.533.331

7485. Adiabatic theory of an electron gun for crossed field devices. J. DAIN AND I. A. D. LEWIS. *Proc. Phys. Soc.* [*London*] *B*, **67**, 449–55 (*June*, 1954).

An electron gun is described capable of producing a ribbon-shaped beam of electrons moving under crossed electric and magnetic fields. The characteristics of the gun are derived by applying the adiabatic principle to motion in constant uniform crossed fields. A.

537.533.35

7486. Electrolytic etching of point cathodes for the field emission electron microscope. F. W. NIEMECK AND D. RUPPIN. *Z. angew. Phys.*, **6**, *No.* 1, 1–3 (1954) *In German.*

A method is described, employing a miniature electrolytic cell, by which it is relatively easy to prepare the very finely pointed tungsten cathodes required in the field emission microscope. A yield of 90% usable cathodes is claimed, with little variation in form and size; the length of the conical portion varies from 0·1–0·3 mm and the radius of the point from 800–1500 Å. The influence of the electrolyte concentration, applied voltage and current density have been investigated, the shape of the points being observed in a normal electron microscope.

V. E. COSSLETT

537.533.35

7487. On the properties of a spectrometer for linear electron accelerators. C. C. GROSJEAN AND V. J. VANHUYSE. *Nuovo Cimento*, **11**, 639–50 (*June*, 1954).

The relativistic equations of motion of an electron in an arbitrary transverse magnetic field with radial symmetry have been solved. A detailed discussion of the exact formulae describing the motion of the particles on their trajectories, leads to the following conclusions: (1) The invariance of the relation between coil current and detected electron energy. (2) The detected beam-current does not directly provide the true energy spectrum, since it is proportional to the product of the beam intensity per unit energy interval times an energy dependent factor. (3) A particular property of the trajectories may possibly lead to a new method for a precision measurement of the electron energy in a monokinetic beam. A.

537.533.7 : 538.569 : 621.385.833

7488. Stored energy and power flow in electron beams. L. R. WALKER. *J. appl. Phys.*, **25**, 615–18 (*May*, 1954).

The problem of finding the density of a.c. energy and the a.c. power flow in an electron beam, originally uniform in velocity and charge density, which interacts with a weak electromagnetic travelling wave, is considered. For the problem to be significant, the way in which the travelling wave is built up must be specified and the energy and power flow turn out to depend upon the method of establishment. A.

537.533.72 : 537.534.72

7489. On the nature of the transcendental curves associated with the relativistic trajectories of charged particles. L. GOLD. *J. appl. Phys.*, **25**, 691–7 (*June*, 1954).

A detailed examination of the relativistic trajectories in the intermediate high-energy range is made for charged particles in crossed magnetic and electric fields for generalized injection states with explicit solutions given in parametric form. The particle path relation is generally formulated, but explicit calculation is offered for the zero velocity injection only. A.

537.533.74

7490. On the scattering of electrons of intermediate energy through the smallest angles. F. LENZ. *Z. Naturforsch.*, **9a**, 185–204 (*March*, 1954) *In German.*

The elastic and inelastic scattering of 50–100 keV electrons through angles between 10^{-4} and 10^{-1} degrees is discussed. Such electrons are important for electron microscopy. The Fermi–Thomas field has the wrong asymptotic behaviour for large distances and since just this region is important for scattering through such small angles, this atomic model leads to incorrect results. Consequently, a simple charge density is substituted which has the correct exponential decrease at large distances, and gives rise to a potential $V = (Ze/4\pi\varepsilon_0 r)e^{-r/R}$. The parameter R is chosen so that this potential, in Born approximation, reproduces Mott scattering for zero angle. A classical formula for inelastic scattering is employed. Multiple scattering is also discussed. G. E. BROWN

537.533.74

7491. Elastic scattering of 125 MeV electrons by mercury. S. BRENNER, G. E. BROWN AND L. R. B. ELTON. *Phil. Mag.*, **45**, 524–32 (*May*, 1954).

The elastic scattering of 125 MeV electrons by the nucleus of mercury is calculated, assuming various spherically symmetric models for the charge distribution. It is found that a square distribution (i.e. $\rho = \rho_0, r < R; \rho = 0, r > R$) gives rise to a rather large oscillatory differential cross-section at wide angles, whereas the cross-section from a distribution

of radius $R = 1{\cdot}2\times10^{-13}\,A^{1/3}$ cm in which the sharp edge of the square distribution is smoothed reproduces the smooth, monotonically decreasing differential cross-section required by the experimental data. A.

537.533.75

7492. Energy loss of electrons in passage through thin films. L. MARTON AND L. B. LEDER. Letter in *Phys. Rev.*, **94**, 203 (*April* 1, 1954).

The energy loss (4–60 eV) of 30 keV electrons in passing through films of metals and insulators, 50–100 Å thick, was determined using an electrostatic method with a resolving power of $1/3{\cdot}5\times10^4$. A table is given indicating up to 6 discrete components in the transmitted beam. M. A. GRACE

537.533.75

7493. Transmission of 0–40 keV electrons by thin films with application to beta-ray spectroscopy. R. O. LANE AND D. J. ZAFFARANO. *Phys. Rev.*, **94**, 960–4 (*May* 15, 1954).

The transmission of electrons in the energy range 0–40 keV by thin plastic and metal films with surface densities of $0{\cdot}023 - 1{\cdot}57$ mg/cm^2 has been measured in detail. The range-energy data resulting is prescribed fairly well by Bethe's average energy-loss theory. One of the films was used as a G.M. counter window in a β-ray spectrometer. The application of the transmission data to the β-ray spectrum obtained for Pm^{147} gave some over-correction, as judged by the Fermi plot, which was attributable chiefly to the unavoidable difference between the collection geometry of the transmission measurement and that of the G.M. counter. A.

537.533.8

7494. A contribution on the clarification of the inaccuracy of secondary electron measurements. O. BEER. *Ann. Phys.* [*Leipzig*] **14**, *No.* 3–5, 201–14 (1954) *In German.*

The details and principle of operation of a new apparatus involving magnetic focusing for the accurate determination of the coefficient of secondary electron emission are described. Measurements are made with silver, molybdenum, aluminium and graphite with primary beam energies up to 2000 V and at temperatures up to 500°C. The results indicate that the temperature coefficient is $<1\%$ in the range 200° to 500°C for metals and there does not appear to be any dependence of the secondary electron velocities upon temperature. The influence of positive ions produced at the target at lower temperatures is discussed. C. G. MORGAN

537.533.8 : 539.166.835

7495. Electron-cascade processes at very high energies. L. LANDAU AND I. POMERANCHUK. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 4, 735–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-210.*

Radiation processes for which the Bethe–Heitler theory of bremsstrahlung is found not to be applicable [Abstr. 5696 (1954)] are examined quantitatively. The emission of photons, both of low frequency and where the photon energy (ω) is of the same order of magnitude as the electron energy (E), are discussed. It is found that no infrared divergences occur in bremsstrahlung. Estimates are made of the corrections to the Bethe–Heitler formulae for the probability of photon emission, angular dependence, energy radiated per unit time, and probability of pair-production by γ-rays, for the case $\omega \sim E$. G. FIELD

537.533.9

7496. The quantum correction in the radiation by energetic accelerated electrons. J. SCHWINGER. *Proc. Nat. Acad. Sci. U.S.A.*, **40**, 132–6 (*Feb.*, 1954).

The correction is calculated to first order in $\hbar$, and can be obtained by the substitution of $\omega(1 + \hbar w/E)$ for ω in the classical formula. G. E. BROWN

537.533.9

7497. Observations on the charging of insulating surfaces by electrons *in vacuo*. G. KNOERZER. *Z. angew. Phys.*, **6**, *No.* 2, 81–8 (1954) *In German.*

Describes an arrangement whereby, for example, the potential difference between a metal plate attached to an insulating disk (on the side remote from the incident electron beam) and a metal ring on the incident side may be measured. Electron energies up to about 60 kV were used. Charging patterns were investigated with a technique similar to that of the Lichtenberg figures. J. D. CRAGGS

537.534

7498. Cyclotron beam energy determination by a time-of-flight method. J. H. MANLEY AND M. J. JAKOBSON. *Rev. sci. Instrum.*, **25**, 368–9 (*April*, 1954).

A simple time-of-flight method has been employed as a means of measuring cyclotron beam energy. Through use of a movable and a fixed stilbene scintillation detector, a phase delay measured in terms of the cyclotron frequency is introduced by the flight time of the beam particles. Results good to 2% in energy have been obtained. These have less precision than the direct errors of the method, largely because of cyclotron instabilities. A.

537.534.08 : 621.385.15 : 621.317.31.024.42

7499. Positive ion counting for mass spectrometer beam currents of 10^{-14} to 10^{-19} ampere. F. A. WHITE AND T. L. COLLINS. *Appl. Spectrosc.*, **8**, 17–23 (*Feb.*, 1954).

A reliable method for detecting and recording very small ion beam currents is described. A twenty-stage electron multiplier is used in conjunction with scalers and other circuitry for counting individual positive ions. Advantages and limitations of this method, as applied to mass spectrometer problems, are discussed. A.

537.534.74

7500. Proton-proton scattering near the interference minimum. D. I. COOPER, D. H. FRISCH AND R. L. ZIMMERMAN. *Phys. Rev.*, **94**, 1209–14 (*June* 1, 1954).

The differential proton-proton scattering cross-section at 45° in the laboratory system has been measured in the energy region 350–420 keV. The interference minimum occurs at $383{\cdot}9 \pm 1{\cdot}5$ keV. The minimum in the ratio to the Mott cross-section thus occurs at $382{\cdot}8 \pm 1{\cdot}5$ keV, and at the latter energy the S-wave phase shift is $\delta_0 = 0{\cdot}2527 \pm 0{\cdot}0011$ radians, in good agreement with the most

recent data in this energy region. The combination of this point with the Wisconsin data alone agrees with the previous analysis of data from a wide range of energies. A.

537.534.74

7501. Proton-proton scattering at 9·7 MeV. B. Cork and W. Hartsough. *Phys. Rev.*, **94**, 1300–3 (*June* 1, 1954).

The differential cross-section for scattering of 9·7 MeV protons from hydrogen gas has been measured. Angles over the range from 27° to 112° in the centre-of-mass system have been measured with a statistical error of less than ±1·0% and a probable error of ±1·1% has been assigned to the absolute values of differential cross-section. It is observed that within the accuracy of the measured cross-section, the scattering can be described as pure *S*-wave. The phase shift analysis is reported in a following paper. A.

537.534.75

7502. Proton stopping power and energy straggling of protons. C. B. Madsen. *K. Danske Vidensk. Selsk., mat.-fys. Medd.*, **27**, *No.* 13, 21 *pp.* (1953).

These were determined for Be, Al, Ag, Cu Au and mica using an electrostatic generator in the range 360–2000 keV. The results are consistent with Warshaw's (1950) measurements below 350 keV and with theoretical stopping formulae, in particular that of J. Lindhard and M. Scharff (1953). W. J. Swiatecki

DISCHARGE TUBES . COUNTERS 537.54

537.542

7503. A source of doubly-ionized helium ions. R. Geller and F. Prevot. *C.R. Acad. Sci.* [*Paris*] **238**, 1578–80 (*April* 12, 1954) *In French.*

A focused monochromatic beam of He^+ ions, accelerated to an energy between 200 and 500 keV, was allowed to strike an intensely localized jet of CO_2 gas. Charge-exchange collisions give rise to an appreciable fraction of α-particles in the beam. These were separated by electrostatic deflection, and currents of from 2 μA at 200 keV to 12 μA at 500 keV were obtained. Similar results were found using more easily condensed gases instead of CO_2. N. M. King

537.542

7504. The effect of the dead-time of Geiger–Müller counters on the direct indication of counting rates. P. Nenning. *Z. angew. Phys.*, **6**, *No.* 4, 145–50 (1954) *In German.*

A theoretical study of the correctons to be made, at various counting rates, due to dead-time counting losses. The results are shown graphically in some detail. J. D. Craggs

537.542

7505. Response of the long counter. R. A. Nobles, R. B. Day, R. L. Henkel, G. A. Jarvis, R. P. Kutarnia, J. L. McKibben, J. E. Perry, Jr and R. K. Smith. *Rev. sci. Instrum.*, **25**, 334–5 (*April*, 1954).

The response of the long counter has been investigated with calibrated neutron sources having average energies up to 5 MeV and has been found to be flat down to a low energy limit that is determined by the construction of the counter. A closer examination reveals fluctuations in the sensitivity of about 5% which occur at resonances for neutron scattering by carbon. One can account qualitatively for these fluctuations in terms of the scattering properties of the carbon present in the paraffin moderator of the counter. A.

537.542

7506. On the temperature dependence of BF_3 proportional neutron counters. J. A. Lockwood, F. R. Woods and E. F. Bennett. *Rev. sci. Instrum.*, **25**, 446–9 (*May*, 1954).

The results obtained on commercial BF_3 neutron counters are reported. The arrangement used is described and the results analysed. The conclusion is reached that during a given pulse there is an increase in the number of negative ions formed by electron attachment with an increase in temperature of the tube. This effect is an equilibrium process. Upon reduction of the tube temperature the tube characteristics return to their original values. The consequence of this temperature dependence on the resultant counting rate is discussed. A.

537.542

7507. Use of proportional counters in the measurement of the specific ionization of charged particles. G. Igo and R. M. Eisberg. *Rev. sci. Instrum.*, **25**, 450–3 (*May*, 1954).

A method has been developed to obtain an accurate estimate of the mean ionization of energetic, heavy charged particles using a device which has small stopping power. A sample of the frequency distribution of energy losses in each of *n* identical proportional counters is obtained. This information is treated by selecting the smallest of the *n* pulses and using this smallest pulse to represent the mean ionization of the particle. The experimental results are compared with Landau's theory of the statistical fluctuations in the specific ionization of charged particles. A.

537.542 : 537.591.8

7508. Statistical errors at background intensities in integrating ionization chambers. P. R. J. Burch. *Proc. Phys. Soc.* [*London*] *A*, **67**, 431–42 (*May*, 1954).

A theoretical analysis of the statistical errors in cylindrical integrating ionization chambers is carried out, attention being given to the different types of ionizing particles encountered at background intensities. The conclusions are compared with experimental data and used to derive a parameter related to the specific ionization and "shower" properties of cosmic-ray particles. Independent considerations show that the value obtained for this parameter is satisfactory. Some practical suggestions are made concerning the minimization of statistical errors. A.

537.542 : 539.166.08

7509. Dependence of the ionization current on the energy of γ-emission. I. V. Éstulin. *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 221–8 (1953) *In Russian.*

The investigation was carried out in air chambers with Pb, and with C, walls. The sensitivity of a slit-type ionization chamber was determined for γ-rays

of 0·3–3 MeV; the experimentally determined sensitivity is close to the calculated value. The ratio of the ionization currents in a Pb and a C chamber depends on the energy of γ-emission. F. LACHMAN

537.542

7510. Intensity corrections for iodine X-rays escaping from sodium iodide scintillation crystals. P. AXEL. Letter in *Rev. sci. Instrum.*, **25**, 391 (*April*, 1954).

In the measurement of γ-ray intensities with a NaI crystal, corrections must be made for those events in which a 24·8 keV iodine X-ray escapes from the crystal. These give rise to an "escape peak" formed below the true photopeak in the amplitude distribution of pulses from the photomultiplier. In this paper the ratio of the integrated intensity of the escape peaks to that of the photopeak is calculated. An "infinitely thick" crystal is assumed, and results are given for various crystal geometries and for γ-ray energies between 33 and 150 keV. D. R. CHICK

537.542

7511. Study of a liquid scintillation counter. D. BRINI, L. PELI, O. RIMONDI AND P. VERONESI. *Nuovo Cimento*, **11**, 655–62 (*June*, 1954).

The counter described is of small thickness (1 cm) and of circular cross-section (10 cm dia.). The measurements have shown that its efficiency in revealing relativistic particles is practically 100%, and that its real diameter corresponds to the geometric one. The measurements permit the conclusion that the collection of light is about 30% of that emitted in scintillation, with a disuniformity in the light collected not greater than 30%. A.

537.542 : 621.375.2.018.75

7512. Effect of steepness of rise and fall of the input pulse on the response of pulse amplifiers. I. B. K. BHATTACHARYYA. *Indian J. Sci.*, **28**, 31–46 (*Jan.*, 1954).

The effect of steepness of pulse-fronts on the response characteristics of RC-coupled pulse amplifiers has been studied. The analytical expressions of the responses of the amplifier to pulses of the following types have been derived: (1) ramp function input pulse; (2) a pulse with linear rise and fall; and (3) a saw-tooth pulse. In the case of a ramp function, input-pulse expressions are deduced relating the rise and delay times of the reproduced pulse with the rise time of the input pulse. In the cases of pulses having sharp rise and fall, formulae are derived for the maximum output voltage obtainable and the time corresponding to this maximum, as a function of times of rise and fall of the input pulse. The response characteristics for all cases of interest have been plotted. A.

537.542 : 621.387.4 : 621.374.3

7513. Auxiliary circuits for particle counters. F. BELLA, C. FRANZINETTI AND F. LEPRI. Letter in *Ricerca sci.*, **23**, 2267–9 (*Dec.*, 1953) *In Italian.*

Two novel features are reported: the use of an electronic quenching circuit and the operation of the counter tube at much higher voltages than hitherto. In two forms of the quenching circuit shown, the output signal from the tube triggers a relaxation oscillator which short-circuits the tube for a definite time which may be varied from practically zero to 50 μsec. One circuit, usable up to 3 kV, employs an 807 valve as the short-circuiting element while the other, for 10 kV uses a 24 G valve. A power supply for this latter use, stabilized to 1% is shown. S. C. DUNN (R)

537.542

7514. New photomultipliers and operating data. B. R. LINDEN. *Nucleonics*, **12**, 20–3 (*March*, 1954).

A method of determining the uniformity of response across the cathodes of photomultipliers, in which the image of a flying spot on an oscillograph screen is focused on the photocathode and the output monitored by an oscillograph or television screen, is described. Results of measurements on the uniformity of photocathode output in 5 in., $\frac{3}{4}$ in. and $1\frac{1}{4}$ in. multiplier tubes, previously described [Abstr. 1418 (1954)] are given. Other measurements on the effect of shield and dynode potentials on pulse height and resolution are also discussed. L. R. SHEPHERD

537.542

7515. On a method for increasing the height of the sensitive volume in a diffusion [Wilson] chamber. A. ROGOZINSKI. Letter in *J. Phys. Radium*, **15**, 304 (*April*, 1954) *In French.*

The sensitive volume may be increased by insertion of a non-conducting (e.g. glass) cylinder fitting in a groove in the base of the chamber and having a radius fairly near to that of the chamber wall. The inner cylinder insulates the sensitive volume from the chamber wall. J. D. CRAGGS

537.542

7516. Influence of the variation of the conditions in a cloud chamber during the sensitive time on the accuracy of cross-section measurements. S. BARILE AND R. WEBELER. Letter in *Rev. sci. Instrum.*, **25**, 389 (*April*, 1954).

An interrupted source of α-particles synchronized in the cycle of operations of a low-pressure cloud chamber has been used to show that the volume change occurring during the sensitive period can be reduced to less than 2%. This enables accurate values of cross-section to be obtained. M. A. GRACE

537.542

7517. Analysis of stereoscopic cloud-chamber photographs. G. MEIJER, R. MENNEGA AND G. J. SIZOO. *Physica*, **20**, 301–6 (*May*, 1954).

A general method is described to derive the coordinates of separate points of Wilson-chamber tracks from the perspective views obtained with two cameras. According to this method a reference system which may consist of two parallel plane rectangular grids, is placed in the cloud-chamber, and perspective views of this system are taken with the same photographical set-up as is used for the tracks. A.

537.543 : 621.385.16.029.6

7518. Relativistic dynamics of a charged particle in crossed magnetic and electric fields with application to the planar magnetron. L. GOLD. *J. appl. Phys.*, **25**, 683–90 (*June*, 1954).

Complete characterization of planar magnetron behaviour is achieved for intermediate relativistic

energies where radiation loss is of no serious consequence. The cut-off condition in the neighbourhood of the rest energy of the particle shows a linear dependency on the product of electrode separation and magnetic field LH rather than the classical $(LH)^2$. The modified period assumes a particularly simple form $2\pi\omega^{-1}(1-\gamma^2)^{-\frac{1}{2}}$, γ being the ratio of electric and magnetic fields which reflects a voltage dependency of the period not encountered in the classical case. A parametric solution for the periodic orbits is derived on the basis of a transformation related to the delineation of the velocity space and, as such, represents a new variety of transcendental curve which degenerates into the cycloid for the limiting case of $\gamma \to 0$. The spatial-time dependent mass, momenta and energy relations take on especially straightforward forms in terms of the trajectory parametric solution. A.

537.543 : 621.385.2/.3

7519. Tube noise under large transit-time conditions. S. V. Yadavalli. *J. appl. Phys.*, **25**, 564–8 (*May*, 1954).

That the noise convection current in a diode would be the same as the noise current in a triode under the conditions $\theta_1 \gg 1$ and $\theta_2 \ll 1$ (θ_1 and θ_2 are transit angles in radians of the potential minimum to grid, and grid to anode regions, respectively) is shown by following the approach indicated by Rack and applying the Llewellyn–Peterson small signal theory to study the noise in a triode. Although the general trend of the experimental results agrees very well with the prediction from the Rack approach, the measured value of noise power is found to be about 2 db below the predicted value. The experimental results are applicable to triodes as well under certain conditions. A.

IONIZATION . THERMIONICS 537.56/.58

537.563

7520. Mass spectrum of methane at elevated pressures. V. M. Kolotyrkin, M. V. Tikhomirov and N. N. Tunitskiĭ. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 6, 1193–5 (1954) *In Russian.*

Presents the results of studies on the pressure-dependence of the "fractional" peaks $11^1/_{13}$ and $10^2/_7$ occurring in CH_4 as a result of processes $CH^+ \to C^+ + H$ and $CH_2^+ \to C^+ + 2H$. The dependence of the intensity (I) of the primary peaks on pressure (p) can be represented by the formula $I = (Ap + Bp^2)\exp(-\kappa p)$, where A is the probability of the primary peak being formed by a collision with an electron, Bp^2 is the term allowing for the possibility of a change in the number of resultant ions, due to collisions in the ionic source, and κ is the coefficient of scattering. If the coefficients of scattering are equal for the primary and secondary ions, then the intensity of the secondary peak $I^* = ICp$. For $B = 0$ and small values of κp, the I^*/I ratio $= (C/A)I[1 + (\kappa/A)I]$. Experiments conducted with a 60° mass spectrometer show that, for the peaks $11^1/_{13}$ and $10^2/_7$, (1), I^*/I is proportional to $\alpha I + \beta I^2$, and (2), at small pressure values, proportional to pressure. The cross-section of the reaction $CH^+ \to C^+ + H$ is of the order of 1×10^{-16} cm^2. F. LACHMAN

537.563.08

7521. An automatic ionization efficiency digital recorder. J. D. Morrison. *Rev. sci. Instrum.*, **25**, 291–2 (*March*, 1954).

The use of time integration to improve the signal-to-noise ratio in ionization efficiency curves obtained with the mass spectrometer requires a large amount of data. An instrument is described which performs the collection of ionization efficiency data automatically, and presents its results as binary numbers, suitable for arithmetic treatment. A.

537.564

7522. Negative ions by dissociation of SO_2 by electron collision and the electron affinity [A] of SO. H. Neuert and O. Rosenbaum. *Naturwissenschaften*, **41**, *No.* 4, 85–6 (1954) *In German.*

The results of mass spectrometer studies show that the ions produced are SO^- and O^-, by the reactions (1) $e + SO_2 \to SO + O^-$, (2) $e + SO_2 \to (SO)^- + O$. Since the dissociation energy is the same for (1) and (2), the measured appearance potentials of O^- and SO^- can be used to calculate A; the value thus obtained was $1{\cdot}8 \pm 0{\cdot}3$ eV. J. DUTTON

537.564 : 537.534.74

7523. Determination of the appearance potentials of molecules by means of a mass spectrometer. H. Neuert. *Angew. Chem.*, **65**, *No.* 17–18, 454–9 (1953) *In German.*

Discusses various possibilities of the formation of negative and positive ions as a result of the dissociation of simple molecules through collision with electrons; analyses the energy balance of the processes involved. Particularly interesting is the determination of the energy of electrons causing dissociation as a result of which an ionic type appears for the first time in the mass spectrometer (the appearance potential). Several methods of determining these potentials are described and compared with each other, and their application and accuracy are discussed. F. LACHMAN

537.565

7524. Mobilities of atomic and molecular ions in the noble gases. M. A. Biondi and L. M. Chanin. *Phys. Rev.*, **94**, 910–16 (*May* 15, 1954).

A method is described for measuring the mobilities of ions of near-thermal energy. A pulse of ions is generated in a discharge region and passes through a grid into a drift region where a uniform electric field causes the ions to move to a collector electrode. The mobilities are determined from measurements of the transit time of the ions in crossing the drift space. The experimental mobility values for thermal energy ions moving in their parent gases at 300°K and a gas density of $2{\cdot}69 \times 10^{19}$ atoms/cm^3 are $\mu_0 = 10{\cdot}5$ cm^2/volt-sec (He^+), $20{\cdot}3$ (He_2^+), $4{\cdot}0$ (Ne^+), $6{\cdot}5$ (Ne_2^+), $1{\cdot}60$ (A^+), $2{\cdot}65$ (A_2^+), $0{\cdot}90$ (Kr^+), $1{\cdot}21$ (Kr_2^+), $0{\cdot}58$ (Xe^+) and $0{\cdot}79$ (Xe_2^+). These values are in good agreement with available theoretical results. The measurements join smoothly at higher ion energies with the measurements made by Hornbeck and by Varney except in the case of A_2^+. In addition, the results indicate that

earlier measurements at near-thermal energy by Tyndall and collaborators refer to the molecular ions in helium and neon, and to the atomic ions in krypton and xenon. A.

537.568

7525. Electron capture cross sections. H. SCHIFF. *Canad. J. Phys.*, **32**, 393–405 (*June*, 1954).

Electron capture cross-sections are calculated in the first Born approximation for α-particles passing through hydrogen and singly-charged helium ions passing through helium using the complete interaction Hamiltonian. Estimations of captures into excited states are made with the help of the partial cross-sections obtained in a simple closed form using only the (incident ion)–(electron) interaction. The results indicate that the first Born approximation, using the complete interaction, is quite adequate in the velocity range given by $e^2/\hbar v \leqslant \sim 1$. An impact parameter calculation for protons in hydrogen shows that the cross-section obtained using only the (incident ion)–(electron) interaction gives unphysical results at low velocities ($e^2/\hbar v \sim 1$), and that most of the contribution to the cross-section arises from impact parameters $p > a_0$, where a_0 is the radius of the first Bohr orbit in hydrogen. A.

537.581

7526. Measurement of the effect of chlorine treatment on the work function of titanium and zirconium. H. MALAMUD AND A. D. KRUMBEIN. *J. appl. Phys.*, **25**, 591–2 (*May*, 1954).

Work function measurements of titanium and zirconium were carried out by the conventional photoelectric method. Two samples of each metal were investigated before and after treatment with chlorine. The changes in work function due to chlorine absorption were of the same order of magnitude as those reported for other halogens on other metals. A.

537.583 : 536.5 : 621.317.39 : 621.385.032.216

7527. New method of measuring the cathode temperature of indirectly heated vacuum tubes. S. IKEHARA. *J. appl. Phys.*, **25**, 725–32 (*June*, 1954).

A new method of determining the cathode temperature of the diode, triode and multigrid tube, using high harmonic component of initial current which flows to the anode when an a.c. voltage is applied to the anode, is presented. The principle and apparatus of this method are described, and the causes of error in measurement are discussed. The advantage of this new method is that the temperature may be read directly; the time for measuring is extremely short; the error due to the leakage current is reduced; and it has a high accuracy (within $\pm 0{\cdot}05\%$) and good reproducibility. Results on diode 6AL5, 6H6, triode 6J6 and pentode 6SH7 taken by this method, and results taken by other methods are compared. A.

537.583 : 621.385.032.216

7528. Reactions between oxide cathodes and gases at very low pressures. S. WAGENER. *Proc. Phys. Soc.* [*London*] *B*, **67**, 369–86 (*May*, 1954).

A method is described for studying the behaviour of oxide cathodes under the impact of gases at pressures between 10^{-7} and 10^{-5} mm Hg. From the cathode under investigation saturated pulsed emission and space-charge-limited emission currents are drawn simultaneously. Whilst the pulsed emisson is used as a measure of thermionic emissivity, the space-charge-limited emission is employed for operating an ionization gauge which indicates the gas pressure directly in front of the cathode. The experimental tube is connected to the pump via a capillary, and the rate of gas flowing into the cathode can be determined from measurements of the two pressures at either end of capillary. The resistance of a cathode to attack by oxygen is found to be independent of the material used for the core but largely dependent on the presence of small traces of other gases and of Ba originating from the getter. The influence of emission current, cathode temperature and gas pressure on rate of poisoning by oxygen is examined. The effect of CO_2 and other gases was also studied. A.

537.583 : 621.385.032.216

7529. On the conductivity of oxide cathode coatings. T. B. TOMLINSON. *J. appl. Phys.*, **25**, 720–4 (*June*, 1954).

Experiments are described which supply evidence on the manner of electrical conduction through the oxide cathode coating. In the first experiment, *I–V* characteristics were obtained using special diodes with embedded probes. Contrary to the Loosjes–Vink theory, the characteristics for temperatures above 700°K are generally linear at high positive and negative potentials but curved at lower potentials. Other experiments would appear to confirm the presence of space charge in the pores of the coating at temperatures above 700°K, and so support the Loosjes–Vink theory for higher temperature conductivity. A modified conduction theory is put forward, and it is shown to fit in with all the known facts. A.

COSMIC RAYS 537.591

537.591.1

7530. On the neutral horizontal component of cosmic radiation. J. CLAY AND M. BRUIN. *Proc. K. Ned. Akad. Wetensch. B*, **57**, 33–44 (*Jan.–Feb.*, 1954).

An experiment was performed in which effects due to the neutral horizontal component of the cosmic radiation were measured at sea level. The results seem to indicate that apart from photons energetic neutrons play an important part as producers of charged secondary particles in lead, aluminium, paraffin and water. A.

537.591.1

7531. On H. Alfvén's theory of the effect of magnetic storms on cosmic ray intensity. W. F. G. SWANN. *J. Franklin Inst.*, **257**, 191–201 (*March*, 1954). Shorter version in *Phys. Rev.*, **93**, 905 (*Feb.* 15, 1954).

H. Alfvén's theory [Abstr. 4853 (1949)] envisages a stream of gas shot out from a place on the sun where there is a large magnetic field. The gas, supposed highly conducting, carries the magnetic field *H* with it, and the field is supposed to be perpendicular to the velocity *v*. A stationary observer observes an electric polarization perpendicular to *H* and *v*, and the potential change across the beam of

width h is calculated as Hvh/C. A cosmic-ray crossing the beam is supposed to change its energy by $Hvhe/C$, and by making H or h large this change of energy can be made as great as is desired. Alfvén calculates a 10% change for the energy of a 3×10^{10} eV ray on crossing a beam of width 5×10^{12} cm carrying a magnetic field of 3×10^{-4} gauss and travelling with a velocity of 2×10^{8} cm/sec. The present paper recognizes that an observer moving with the beam observes no change of energy, and by a relativity transformation, it is shown that a fixed observer cannot observe a change of energy greater than $2vW/C$, where W is the energy of the cosmic ray. This change amounts to only about 1·4%. The discrepancy between the conclusions from relativity and those drawn by Alfvén are shown to arise from the fact that the cosmic-ray path in the example considered by Alfvén would have, in the beam, a radius of curvature 15 times smaller than the beam width and so could never cross it. Thus relativity gives for the change of energy of the beam an upper limit of the order $2v/C$ times the energy of the beam, and this limit can never be exceeded, however large H or h may be chosen. An analysis of the considerations resulting from the assumption of a finite conductivity for the space external to the beam shows that the existence of such a conductivity does not change the conclusions. A.

537.591.1

7532. Magnetic storm effect on cosmic radiation. H. Alfvén. Letter in *Phys. Rev.*, **94**, 1082 (*May* 15, 1954).

Alfvén writes to the effect that Swann's objections (preceding abstract) are not valid.

537.591.1

7533. Energetic nuclear collisions in the upper atmosphere. II. The muon component. U. Haber-Schaim and G. Yekutieli. *Nuovo Cimento*, **11**, 683–5 (*June*, 1954).

The flux of pions in the upper atmosphere calculated in Pt I [Abstr. 3625 (1954)] is used to determine the flux of muons in the atmosphere. In particular, the energy spectrum of muons at sea level in the energy band 30–1000 Mc^2 is evaluated and compared with experiment. A.

537.591.15

7534. On the production of penetrating showers in hydrogen and carbon. P. Colombino, S. Ferroni and G. Wataghin. *Nuovo Cimento*, **11**, 572–4 (*May*, 1954).

A counter hodoscope set has been used simultaneously to investigate the production of penetrating showers in carbon and hydrogen. The observed events are classified in three groups. (1) Events due to dense incident penetrating showers; (2) events generated by single charged particles (mostly protons); and (3) events generated by neutral particles (neutrons). The production in hydrogen (paraffin minus carbon) of showers of 3, 4 or 5 particles appears to have a greater cross-section for neutrons than protons, but for higher multiplicities no difference is observed. The results indicate an average multiplicity ~3 for mesons produced in collisions with protons in paraffin. H. ELLIOT

537.591.15

7535. Structure and composition of air shower cores. H. L. Kasnitz and K. Sitte. *Phys. Rev.*, **94**, 977–87 (*May* 15, 1954).

Extensive air showers were observed with an arrangement in which details of their structure and composition could be studied with the help of a large cloud chamber and a 102-counter hodoscope, while extension trays permitted a classification of the showers in three groups according to their initial energy, and a selection favouring events with cores striking near the central cloud chamber-hodoscope set. The electron density distribution is found to be flatter than the Molière structure function, and despite the different shower ages in the three energy groups, to be nearly the same for all the showers recorded. A structure function $\phi(r)\propto r^{-0\cdot76}$ to $r^{-0\cdot85}$ in the immediate neighbourhood of the core fits the data best. An attempt to correlate the very dense local cascades started by high-energy electrons or photons with the expected multiple cores representing the high multiplicity of the nuclear interaction initiating the shower failed; the structure of the groups of local cascades observed does not appear to vary with the shower energy. The penetrating component contains N particles interacting in the lead plates of the chamber with a mean free path of approximately 165 g/cm², and consisting of neutrons (41 ± 8%) and charged particles. The total abundance of penetrating particles near the core does not differ appreciably from that found by various authors in experiments not as strongly biased in favour of the detection of shower cores. The abundance ratios of N particles to μ-mesons, and of penetrating particles to electrons, show only slight variations with the shower age and demonstrate that the nucleonic cascade reaches its maximum somewhat later than the electron cascade. A.

537.591.15

7536. Development of air showers in the atmosphere. K. Sitte, D. L. Stierwalt and I. L. Kofsky. *Phys. Rev.*, **94**, 988–93 (*May* 15, 1954).

An experiment was carried out at Mt. Evans, Colorado (altitude 4300 m) to study the development of extensive air showers in the atmosphere. Showers with cores striking near a cloud-chamber-hodoscope arrangement were selected, and the differential energy spectrum of the shower particles determined by observing their transition effect in six ½ in. lead plates with a 68-counter hodoscope. Each shower can be assigned an age classification on the basis of this energy spectrum. The lateral structure function between 2 m and 8 m from the core was obtained from measurements of the particle densities at four extension trays containing 50 counters with a total area of 1·34 m². It was found from the hodoscope data that the lateral structure function of the showers of various ages does not agree well with the predictions of the single-particle cascade theory. The observed structure function for showers at and beyond the cascade maximum is less steep than expected near the axis; this is consistent with multiple production of shower-producing particles in the primary collision. It was also found that the lateral distribution of showers past the cascade maximum varies only slowly

with age; this tendency is predicted in a general way by the cascade theory, but only at a much later stage of development than observed and with quite a different slope of the distribution curve. The interpretation of this effect as the result of a "rejuvenation" of the shower by the continuous transfer of energy from the nucleonic cascade to the electron cascade is therefore more likely. A.

537.591.3

7537. On [the] Rossi curve and anomalous photon absorption. P. K. S. CHOUDHURY. Note in *Z. Naturforsch.*, **9a**, 175 (*Feb.*, 1954).

It is suggested that the anomalous absorption of RaC γ-rays is connected with the second and third Rossi maximum under lead. The author concludes that both effects can be interpreted only by assuming the existence of a new kind of penetrating radiation of secondary origin. H. ELLIOT

537.591.3

7538. Exponents of the absorption law for the polar and equatorial regions. D. S. R. MURTY. Letter in *Curr. Sci.*, **23**, 88–9 (*March*, 1954).

The difference δ ($=\Delta n$) between the exponents of the cosmic-ray absorption law $I = A/h^n$ for the polar and equatorial regions has been determined from an analysis of the east-west asymmetry at geomagnetic latitude 7° 39′. The value obtained for δ is $0{\cdot}12 \pm 0{\cdot}015$. H. ELLIOT

537.591.5

7539. Cosmic-radiation intensity-time variations and their origin. III. The origin of 27-day variations. J. A. SIMPSON. *Phys. Rev.*, **94**, 426–40 (*April* 15, 1954).

For Pt II, see Abstr. 6925 (1953). It is shown that (*a*) the 27-day recurring cosmic-radiation intensity variations are not produced by geomagnetic field disturbances, and (*b*) this 27-day variation is a primary intensity variation produced by a charged particle accelerating mechanism. These results were obtained without invoking special models for the magnetic field disturbances or requiring detailed time correspondence between cosmic-radiation intensity and magnetic field intensity variations. The conclusions were based upon experimental observations covering a 19-month period in 1951 and 1952. The results are derived from neutron-intensity variations measured as a function of time in aircraft and neutron monitor piles. The data reveal that an indirect association exists between the 27-day intensity variation and geomagnetic disturbances: i.e. geomagnetic disturbances are most likely to occur approximately 2 days after the 27-day maxima of cosmic-ray intensity. It is also shown that intensity changes of $\sim$3–6% are sometimes not followed by any geomagnetic disturbance. An example is given of a nonrecurring sharp intensity decrease of $>$6%, and it is shown that even this event is not produced by geomagnetic field variations. The results suggest that there is a common mechanism which produces both the accelerating process for cosmic-radiation particles and, indirectly, the geomagnetic disturbances. A search was made for the probable location of such a mechanism. Varying electrical fields of terrestrial origin were considered whereby the incoming primary radiation would undergo an acceleration or deceleration either (1) before entering the geomagnetic field, (2) within the magnetic field region or (3) after passing through the magnetic field. None of these three possibilities, nor a combined geomagnetic and geoelectric field storm, accounts for all the established experimental facts. In view of these results it is concluded that the accelerating mechanism probably is not of terrestrial origin. The 27-day recurrence corresponds in time to the proper rotation of the solar equatorial latitudes and, since it has been shown that active solar regions at these latitudes are associated with the 27-day cosmic-radiation intensity variations, the required accelerating mechanism is probably controlled by solar processes and may be located near the sun. From the dependence of the 27-day intensity variation upon particle rigidity, the experimental results show that primary protons undergo the variation, but it is still not proved whether or not particles of $Z \geqslant 2$ also display this variation. The experimental data also exclude the production of this variation by the influence of a solar dipole magnetic field. A.

537.591.5

7540. Time and directional study of primary heavy nuclei. G. W. ANDERSON, P. S. FREIER AND J. E. NAUGLE. *Phys. Rev.*, **94**, 1317–22 (*June* 1, 1954).

The "plate mover" technique has been used in two emulsion studies of the time dependence of the flux of primary heavy nuclei ($Z \geqslant 10$). No evidence for the previously reported "day-night" effect was found. The angular distribution was studied on an oriented flight, and some statistically significant azimuthal asymmetries were noted, but these showed no obvious trend in time. The absorption mean free path was found to be 19 g/cm^2, independent of depth in the atmosphere for depths $\geqslant 18{\cdot}5$ g/cm^2. A.

537.591.5 : 523.75

Cosmic ray effects associated with solar flares. *See Abstr.* 7083

537.591.5 : 550.384

7541. On the diurnal variation of cosmic rays. III. Semi-diurnal variation and magnetic disturbance. Y. SEKIDO AND S. YOSHIDA. *Rep. Ionosphere Res. Japan*, **5**, *No.* 1, 43–6 (1951).

For Pt I, see Abstr. 569 (1954). Semi-diurnal variation in cosmic-ray intensity on magnetically disturbed and quiet days was statistically studied on the basis of various kinds of observation. In general it was found that its amplitude decreases on magnetically disturbed days. The decrease observed with the narrowest-aperture instrument was more noticeable than the ones observed with the other instruments. A.

537.591.5 : 550.384

7542. Diurnal variation of vertical cosmic rays—relation to magnetic character figure. Y. SEKIDO AND M. KODAMA. *Rep. Ionosphere Res. Japan*, **6**, 111–16 (*June*, 1952).

The relation between the cosmic-ray diurnal variation and magnetic character figure was statistically studied on data observed from 1949 to 1951. The amplitude of the diurnal variation increased and the time of maximum intensity became earlier with the increment of magnetic character figure. This tendency

was more remarkable for the vertical cosmic-ray component. A.

537.591.8

7543. Experiments on the Cherenkov effect [produced by cosmic rays] in air. A. Ascoli Balzanelli and R. Ascoli. Letter in *Nuovo Cimento*, **11**, 562–4 (*May*, 1954) *In Italian.*

A vertical tube with reflecting walls is closed at the top by a blackened plate and at the bottom by a parabolic mirror concentrating the radiation on a photomultiplier. Direct effect on the photocathode is eliminated by means of a counter telescope. An opaque screen may be placed in front of the photocathode. Experiments with and without the screen and with the tube upright or upside down have revealed the Cherenkov radiation produced in air by cosmic-ray particles; its intensity was of the expected order of magnitude. L. PINCHERLE

537.591.8

7544. Cosmic radiation: ionization intensity and specific ionization in air at sea level. P. R. J. Burch. *Proc. Phys. Soc.* [*London*] *A*, **67**, 421–30 (*May*, 1954).

The lack of agreement between different estimates of the cosmic radiation ionization intensity under similar conditions at sea level is pointed out, and arguments supported by experiment are advanced in favour of J. Clay's procedure for interpreting high-pressure ionization chamber data. An average specific ionization is obtained from the ionization intensity and a recently published value for the absolute particle intensity. The significance of the result is discussed and compared with the value computed from formulae for the energy loss by ionization. A.

537.591.8

7545. Production of π-mesons in carbon and aluminium. M. L. Calzolari, G. Dascola, A. Gainotti and S. Mora. Letter in *Nuovo Cimento*, **11**, 565–7 (*May*, 1954) *In Italian.*

Ilford G5 nuclear emulsions were exposed vertically at 4550 m on Monte Rosa, surrounded by 7 cm of graphite, by 5 cm of aluminium, and without absorber, for 16 days. The numbers of π-mesons produced by cosmic-rays per unit volume of each material, and ending in the emulsion, were deduced from the numbers of σ-mesons, and π–μ decays observed in the emulsions. From these the ratio of the cross-sections for π-meson production in Al and C was found to be $1{\cdot}6 \pm 0{\cdot}6$. This result indicates that for materials of low atomic weight, the cross-section for μ-meson production increases as $A^{\frac{2}{3}}$, agreeing with experiments performed with artificially produced mesons. P. ROTHWELL

MAGNETISM 538

538.082 : 621.317.4

7546. A comparator for materials of low magnetic susceptibility. D. A. Abbott and R. Kilgour. *J. sci. Instrum.*, **31**, 155–8 (*May*, 1954).

Describes an instrument for comparing the magnetic states of weakly magnetic materials, such as phosphor bronze, copper, filled rubber, etc. The force generated between a suspended magnet and the sample under test causes deflection of a light beam. The instrument, as used, is suitable for comparisons in the range $\mu = 1 \pm 0{\cdot}00001$ to $\mu = 1 \pm 0{\cdot}0002$, but it can be adjusted to cover other values of μ. It has been found particularly useful for detecting magnetic contamination in fine gauge Cu wire for instrument work. A.

538.082/.083

7547. The adaptation of the pendulum magnetometer to the measurement of thin ferromagnetic layers. J. Brož. Letter in *Czech. J. Phys.*, **4**, 96 (*Feb.*, 1954) *In Russian.*

It is suggested that the force on a thin sheet of the material in an inhomogeneous field can be measured by the use of a torsion fibre if it is converted into a couple by placing the sample on the end of a rod suspended from the fibre. Calculations show that measurable deflections can be obtained for sheets as thin as 10^{-5} cm. J. M. HOUGH

538.114

7548. Magnetic surface anisotropy and superlattice formation by orientation. L. Néel. *J. Phys. Radium*, **15**, 225–39 (*April*, 1954). *In French.*

A full account of work previously summarized [Abstr. 4693–5 (1954)]. Application of the theoretical ideas is made to the magnetic properties of Permalloy, anisotropic Alnico, cobalt ferrite and certain Fe–Ni alloys with anisotropic properties. E. P. WOHLFARTH

538.114

7549. Antiferromagnetism in metals. A. B. Lidiard. *Proc. Roy. Soc. A*, **224**, 161–76 (*June* 22, 1954).

Neutron diffraction studies of chromium and manganese by Shull and Wilkinson [Abstr. 8525 (1953)] have disclosed the existence of a partial antiferromagnetic ordering in these metals, dissimilar in several respects from the antiferromagnetism which occurs in compounds such as MnF_2 and MnO. The present paper proposes a simple formulation of an energy-band theory of antiferromagnetism based on the assumption that the magnetically effective electrons are in non-localized states. It is shown how this approach leads to an understanding of the differences between antiferromagnetic metals and antiferromagnetic compounds, which are better treated by assuming that the electrons are in localized states. In particular, it is shown why Cr and Mn do not present observable anomalies in specific heat and susceptibility at the Curie point. Finally, it is pointed out that the occurrence of antiferromagnetism in palladium may be the explanation of the gentle susceptibility maximum at 80°K observed by Hoare and Mathews. A.

538.22

7550. Progress in the field of dia- and para-magnetism. G. Joos. *Z. angew. Phys.*, **6**, *No.* 1, 43–8 (1954) *In German.*

A review covering the magnetic moments of fundamental particles, the periodic dependence of susceptibility with field strength for metallic crystals (de Haas–van Alphen effect), low-temperature susceptibilities and paramagnetic resonance.

D. H. WHIFFEN

538.22 : 536.424

7551. Curie point transitions in phosphides and arsenides of manganese. K. H. SWEENY AND A. B. SCOTT. *J. chem. Phys.*, **22**, 917–21 (*May*, 1954).

The relative permeability of several alloys of manganese with phosphorus and arsenic have been measured in the region of the Curie point. The alloys were heated and cooled very slowly to eliminate, as much as possible, irreversible effects. The composition range investigated included alloys of higher phosphorus and arsenic content than have previously been investigated. Ferromagnetism in the phosphorus alloys appears to be due to the compound MnP over the range 27–58 mole percent P, and the magnetic and density transitions exhibit no temperature hysteresis. The temperature hysteresis in the magnetic transformation of manganese arsenide is confirmed. The Curie point/composition relation for the arsenides is discussed and evidence presented for the existence of a manganese-rich compound, perhaps Mn_8As_7, rather than a solid solution of Mn in MnAs. A.

538.221

7552. Relaxation phenomena during irreversible magnetization changes in high-permeability ferrites. T. EINSELE. *Z. angew. Phys.*, **6**, *No.* 2, 70–80 (1954) *In German.*

Describes experiments on the distortion of the hysteresis loop of various ferrite materials under pulsed conditions with increasing speed of induction $\dot{B}$. The distortion is shown to be proportional to $\dot{B}^p$, $p \simeq 0{\cdot}6$. The nature of the processes of magnetization and of the relaxation mechanism is discussed. E. P. WOHLFARTH

538.221

7553. Magnetic dispersion spectrum of a Ni–Zn ferrite. I. LUCAS. *Z. angew. Phys.*, **6**, *No.* 3, 127–30 (1954) *In German.*

Derives a formula

$$\tan \delta/\chi_0 = (\omega/\omega_1^2 t\chi_0)\{(1 - \omega^2/\omega_1^2)^{-1} - 1/3\},$$

where δ is the loss angle, $\chi_0 = A/\omega_1$ the static susceptibility, t the time of relaxation (here equal to $0{\cdot}6$ μsec), ω the frequency and A and ω_1 are constants. The effect on the width of the dispersion region of internal demagnetization effects on the surface of domain boundaries is also considered. See also Abstr. 5562 (1951), 6130 (1953). E. P. WOHLFARTH

538.221

7554. Explanation of the antiferromagnetic conditions in the cumuli during crystallization in the Cu–Fe system. A. KNAPPWOST. *Z. Elektrochem.*, **58**, *No.* 1, 65–6 (1954) *In German.*

Magnetic measurements conducted during the separation of the Cu–Co mixed crystals show that antiferromagnetism of the cumuli in the Cu–Fe system is related to the γ-state of Fe, which is stabilized below definite cumulus-particle sizes by the cubic face-centred Cu lattice. The irreversible generation of ferromagnetism in alloys with condensed cumuli at the boiling-point of N is considered to be a martensitic transformation. F. LACHMAN

538.221

7555. Anisotropy energy and magnetic hardness of monocrystalline magnetite. H. DANAN. *C.R. Acad. Sci.* [*Paris*] **238**, 1304–6 (*March* 22, 1954) *In French.*

Describes room temperature experiments on four natural crystals in fields up to $2{\cdot}5\times10^4$ oersted. Measurements were made before and after heat treatment designed to relieve internal strains which affect the results. Values of K (equal to $-1{\cdot}12\times10^5$ for one of the annealed specimens) and of the hardness constants a along the principal axes are given, a_{111}/a_{100} being equal to about $0{\cdot}65$. E. P. WOHLFARTH

538.221

7556. Magnetic viscosity in precipitation alloys: FeNiAl, Fe_2NiAl and Alnico. J. H. PHILLIPS, R. STREET AND J. C. WOOLLEY. *Phil. Mag.*, **45**, 505–23 (*May*, 1954).

Investigations on the effects of various heat treatments on magnetic viscosity in FeNiAl, Fe_2NiAl and Alnico are described. The heat treatments adopted were (*a*) quenching at different rates from the solution temperature, (*b*) annealing of water-quenched specimens at different temperatures in ranges where precipitation takes place and (*c*) annealing of specimens which have been cooled at different rates from the solution temperature. The results are interpreted in terms of the thermal activation theory of magnetic viscosity, Néel's disperse field theory and Geisler's theory of coherency hardening. It is shown that magnetic viscosity methods can be applied to investigate precipitate and magnetic structures of the order 10^{-17} cm^3 in volume, which are below the limit of resolution of more conventional techniques. Specimens of Alnico and Fe_2NiAl were suitably treated to enable magnetic viscosity measurements to be made at temperatures up to 900°K. The results obtained together with those previously reported show that the thermal activation theory is valid at least over the temperature range 90°K to 900°K. The variation of the coercive force of these alloys as a function of temperature is also considered. A.

538.221

7557. Some magnetic properties of Dy metal. J. F. ELLIOTT, S. LEGVOLD AND F. H. SPEDDING. *Phys. Rev.*, **94**, 1143–5 (*June* 1, 1954).

The magnetic moment of dysprosium has been measured in applied fields of 4000–18 000 oersteds, over the temperature range of 4·2–202°K. The susceptibility of dysprosium was found to be field-dependent below about 175°K. Below 90°K, dysprosium appeared to have true though abnormal ferromagnetic properties, confirming the previous work of Trombe. At hydrogen and helium temperatures the magnetization isotherms fell below the 31°K isotherm. An absolute saturation magnetic moment of at least 8 Bohr magnetons was indicated by the data obtained in the temperature range of 31°K to 80°K. The magnitude of the measured values of the magnetic moment of dysprosium indicated that the orbital angular momentum of the $4f$ electrons contributes to the ferromagnetism. A.

538.221

7558. Antiferromagnetic H–T boundaries and apparent molecular fields for $MnCl_2.4H_2O$ and $MnBr_2.4H_2O$ W. E. HENRY. *Phys. Rev.*, **94**, 1146–51 (*June* 1, 1954).

Experimental study and analysis have been made of

non-Brillouin magnetic moments of two hydrated manganous salts of similar structure. The moment (M) was measured as a function of field at constant temperature (T) and as a function of temperature at constant field (H). From the former, analysis of the extent of the nonsuperposition of $M(H/T)$ for different temperatures gave apparent molecular fields of 14 000 gauss and 18 000 gauss, respectively, for manganous chloride tetrahydrate and manganous bromide tetrahydrate. The Van Vleck antiferromagnetic exchange coefficient γ is experimentally determined, corresponding to antiferromagnetic exchange energy densities of the order of 10^6 ergs/cm^3. The constant field measurements gave points on antiferromagnetic transition curves such that H_m/T_N was about 8000 gauss per degree for each salt. If the constant temperature moment is plotted against the Van Vleck parameter $(H - \gamma M)/T$ instead of the usual Brillouin parameter H/T there is superposition of isotherms for points in the H–T plane outside the antiferromagnetic region, thus giving experimental support to the Van Vleck model for simple antiferromagnetics. The method of measurement is the same as for previous measurements [Abstr. 4915 (1953)]. The temperature range was $1{\cdot}3 - 4{\cdot}2$°K and magnetic fields up to 58 000 gauss were applied, the greater part of the range being such as to prevent antiferromagnetic ordering.

538.221 : 539.23 : 531.717

7559. Ferromagnetism of thin nickel films. H. H. Jensen and A. Nielsen. *Trans Danish Acad. Tech. Sci., No.* 2, 14 *pp.* (1953).

The saturation magnetic polarization of nickel films of thickness ranging from about 8 to 500 Å, evaporated on glass, has been measured. It decreases rapidly below about 100 Å and vanishes below 16 ± 4 Å. An absolute method of determining the film thickness by means of magnetic measurements is described and the results compared with thickness determinations by weighing. A.

538.221 : 548.7

7560. Calculations of the first ferromagnetic anisotropy coefficient, gyromagnetic ratio and spectroscopic splitting factor for nickel. G. C. Fletcher. *Proc. Phys. Soc.* [*London*] *A*, **67**, 505–19 (*June*, 1954).

Calculations are made of the first anisotropy coefficient K_1 and of the spectroscopic splitting factor g for nickel, based on the collective electron theory of the corresponding effects due to Brooks (1940) and the calculations of the author of the $N(E)$ curve for the 3d electrons in nickel. Brooks' theory is reviewed, the underlying assumptions and approximations examined, some minor errors are corrected and it is extended to provide a formula for the gyromagnetic ratio g'. The value of -5×10^7 erg. cm^{-3} obtained for K_1 is considerably larger than the best available experimental value of -8×10^5 erg.cm^{-3} for nickel at 0°K and Brooks' estimate of -8×10^5 erg.cm^{-3}. The values of 2·14 and 1·84 are obtained for g and g' respectively as compared with experimental values of 2·19–2·42 and 1·93. Possible reasons for the discrepancies are discussed. Finally Brooks' theory is formally extended to remove one of the major approximations. A.

538.222

7561. Paramagnetism and electron distribution in the compounds $NiAl_3$, $CoAl_4$, $FeAl_3$, $MnAl_6$ and $CrAl_7$. G. Foëx and J. Wucher. *C.R. Acad. Sci.* [*Paris*] **238**, 1281–3 (*March* 22, 1954) *In French.*

Describes susceptibility measurements between room temp. and 375°C. For the Ni and Co compounds χ is low and almost temperature independent; for $FeAl_3$ χ is large and obeys the Curie–Weiss law above about 240°C ($p_B = 1{\cdot}67$); for the Mn and Cr compounds χ is low and increases slightly with increasing temperature. The results are discussed in relation to Raynor's experiments. Susceptibility results for pure Al are obtained incidentally.

E. P. WOHLFARTH

538.222

7562. R.F. phase-sensitive detector for nuclear magnetic resonance signals. E. B. Baker. Letter in *Rev. sci. Instrum.*, **25**, 390 (*April*, 1954).

538.222

7563. Paramagnetic resonance in irradiated ice. B. Smaller, M. S. Matheson and E. L. Yasaitis. Letter in *Phys. Rev.*, **94**, 202 (*April* 1, 1954).

$g = 2{\cdot}0$ resonances observed at 77°K in H_2O and D_2O irradiated with Co^{60} γ-radiation are attributed to H (2 hyperfine lines) and D (3 hyperfine lines at 1 : 2 : 1 intensity ratio) atoms. At lower temperatures there may be OH radicals also. D. H. WHIFFEN

538.222

7564. Principal magnetic susceptibilities of a crystal of siderite and of manganous fluoride. H. Bizette and B. Tsaï. *C.R. Acad. Sci.* [*Paris*] **238**, 1575–6 (*April* 12, 1954) *In French.*

Gives results of measurements for siderite (containing 73·8% $FeCO_3$) and MnF_2 crystals between 4°K and room temperature. The measured antiferromagnetic Curie temperatures are 35° and 70°K respectively. E. P. WOHLFARTH

538.222

7565. The magnetic susceptibility of the transition elements. C. J. Kriessman and H. B. Callen. *Phys. Rev.*, **94**, 837–44 (*May* 15, 1954).

The available data on the temperature dependence of the paramagnetic susceptibility of the transition elements are reviewed. A theoretical treatment according to the band theory of solids is developed explicitly by means of a simple approximation to the Fermi function. Each term in the resulting theoretical formula may be directly and graphically interpreted in terms of the geometry of the density-of-states curve, allowing a simple and intuitive analysis of the susceptibility variation at any temperature. The empirical data on the temperature coefficient of susceptibility, on the absolute magnitude of the susceptibility, and on the specific heats of the transition elements are analysed to suggest probable alterations in the available theoretical density-of-states curves. A.

538.222

7566. The magnetic susceptibility of nitric oxide in a clathrate compound. A. H. Cooke and H. J. Duffus. *Proc. Phys. Soc.* [*London*] *A*, **67**, 525–7 (*June*, 1954).

The magnetic susceptibility of nitric oxide enclosed in a β-quinol lattice has been measured at temperatures

from 10°K to 300°K. The susceptibility, which obeys Curie's law at room temperature, approaches a temperature-independent value at low temperatures. This behaviour is compared with that predicted for the free gas by Van Vleck. A.

538.222 : 532.7

7567. Parmagnetic resonance absorption in solutions of potassium in liquid ammonia. C. A. HUTCHISON, JR. *J. phys. Chem.*, **57**, 546–53 (*June*, 1953).

The application of the theory and techniques of electronic magnetic resonance to the study of the paramagnetism of solutions of K in liquid NH_3 is described. A.

538.222 : 536.413/.414

7568. Magnetic and thermal expansion investigation of the formation of $CeMg_2$. F. GAUME-MAHN AND M. COHEN. *C.R. Acad. Sci.* [*Paris*] **238**, 1302–3 (*March* 22, 1954) *In French.*

The paramagnetic susceptibility and the differential expansion coefficient both change rapidly at 640°C (heating) and 580°C (cooling). E. P. WOHLFARTH

538.222 : 541.15

7569. Detection of paramagnetic resonance in certain irradiated organic substances. J. COMBRISSON AND J. UEBERSFELD. *C.R. Acad. Sci.* [*Paris*] **238**, 1397–8 (*March* 29, 1954) *In French.*

Irradiation with γ-rays produces free radicals in amino-acids, e.g. glycine, leucine, alanine, etc., in sugars, e.g. glucose, lactose, inuline, etc., and in plastics, e.g. polyethylene, Nylon, polystyrene, etc., which are detectable by paramagnetic electron resonance at 9000 Mc/s. Spin 1 of the N atoms gives rise to three peaks 25 gauss apart in the amino acid radicals. D. H. WHIFFEN

538.222 : 541.183.5

Magnetic ortho-para conversion of hydrogen on diamagnetic solids. *See Abstr.* 7839–40

538.24

7570. Experimental verification of Arkad'ev's assumption on the linearity of the back shearing curve. J. ŠTERNBERK. *Czech. J. Phys.*, **3**, *No.* 2, 151–61 (1953). *In Russian.* Summary (400 words) in English.

Describes measurements of the effective demagnetizing factors N of steel bars surrounded by search coils of differing lengths, placed at various points on the bar. The variation of N with induction was investigated and constancy up to $B = 15\,000$ gauss obtained under certain conditions. Reference is made to theoretical work by V. K. Arkad'ev [*Izv. Akad. Nauk SSSR*, **129** (1946)]. See also Abstr. 5809 (1954).

E. P. WOHLFARTH

538.24 : 621.318.1.013

7571. The causes of deviations from Rayleigh's law of magnetizing effects at small field strengths. G. SORGER. *Frequenz*, **8**, 41–7 (*Feb.*, 1954) *In German.*

Such deviations arise in the case of certain Si–Fe alloys and are found to be dependent upon field strength, temperature and frequency. Secondary effects or lag (Nachwirkung) have been observed in magnetic induction resulting from small magnetizing forces by Richter in the case of carbonyl iron and these effects are considered, as far as field strength changes are concerned, as a possible explanation. As a result, a modified form of the original Rayleig equation is introduced which includes a ter dependent upon the energy associated with the seco dary effect. Good agreement is obtained betwee computed and test results and the secondary effect clearly seen at low temperatures in alloys with hig Fe content. An abnormality in the hysteresis loop the shape of a constriction near the centre is likewi explained. H. G. M. SPRATT

538.2

7572. The gyromagnetic ratios of the ferromagneti of the group Fe–Co–Ni and the experimental results S. J. Barnett. S. BROWN AND A. J.-P. MEYER. *C. Acad. Sci.* [*Paris*] **238**, 1480–2 (*April* 5, 1954) *French.*

Calculates the values of g' for the binary inte ferromagnetic alloys on the basis of an empiric theoretical scheme due to Forrer, and makes co parison with Barnett's experimental results. T agreement is fair. E. P. WOHLFAR

538.2

7573. Magnetization near saturation of iron a iron-cobalts at various temperatures. S. PAN. *Ac Sci. Sinica*, **1**, 133–51 (*Dec.*, 1952).

The approach to magnetic saturation in the ca of iron, nickel and a number of iron–cobalt alloys various temperatures has been studied in the range field from a few hundred to 6000 oersteds. It has be found that for annealed and moderately cold-work specimens the differential susceptibility can represented fairly accurately by a formula of the fo $(\partial I/\partial H)_T = (A/H^2) + (2B/H^3) + (C/\sqrt{H}) + D$, wh I is the magnetization, H the applied field, and T temperature. Near room temperature, the last terms taken together are so small compared with first two that they can be approximated by a sin constant. For a specimen starting in the annea state both the coefficients A and B increase t mendously at first with the amount of cold-work specimen receives, but the formula fails to apply wh the specimen is severely cold-worked. For annea specimens these cofficients decrease with increas temperature, vanishing at considerable distan below the Curie point. In general, D cannot evaluated with certainty from the present da However, the coefficient C evaluated by neglect D is in satisfactory agreement with the theoret results of Holstein and Primakoff in so far as order of magnitude and the way in which it va with the temperature are concerned. B is undoubte proportional to K_1^2/I_s where K_1 is the first magne crystalline anisotropy coefficient and I_s the saturat magnetization. However, values of K_1 obtained comparing theory and experiment are satisfact only in regard to the order of magnitude.

538.27 : 53

7574. de Haas-van Alphen effect in cadmi T. G. BERLINCOURT. *Phys. Rev.*, **94**, 1172–8 (*Jun* 1954).

The de Haas–van Alphen effect (periodic de dence of magnetic susceptibility upon magnetic fi has been investigated in single crystals of cadmiu the liquid helium temperature range and in magn fields up to 25 kilogauss. The orientation depend

of the effect in cadmium was found to be different from all other known cases and cannot be interpreted in terms of ellipsoidal constant energy surfaces or other constant energy surfaces obtainable by the usual transformations from the isotropic case. The susceptibility oscillations of maximum period $\beta/E_0 = 1{\cdot}88\times10^{-7}$ gauss^{-1} occur whenever the magnetic field makes an angle of 28·5° with the hexagonal axis. The chemical potential of the pertinent electrons is $E_0 = 69{\cdot}6\times10^{-14}$ erg $= 0{\cdot}435$ eV to an estimated accuracy of ±1%. Unsuccessful attempts were made to observe the de Haas–van Alphen effect in single crystals of Ta, Mo and hexagonal Ti. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

7575. On the Maxwell tensor. S. SLANSKY. *C.R. Acad. Sci.* [*Paris*] **238,** 1103–4 (*March* 8, 1954) *In French.*

Fundamental laws are unchanged if the Maxwell tensor M_r^s is replaced by a new tensor T_r^s such that $T_r^s - M_r^s = N_{r,q}^{sq}$, an explicit expression being given for N. The new tensor is such that the energy density is constant for a plane monochromatic wave, and is zero for static field *in vacuo*. R. A. NEWING

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561

7576. On the asymptotic behaviour of the solution of a problem in magneto-hydrodynamics. I. R. NARDINI. *R.C. Accad. Naz. Lincei,* **16,** 225–31 (*Feb.*, 1954) *In Italian.*

A uniform liquid of density δ and conductivity γ is initially at rest in the region $z > 0$ under the action of a uniform magnetic field H_0 parallel to Oz. Subsequent motion parallel to the plane $z = 0$ under the action of a variable magnetic field applied in this plane has been investigated [*Ann. Mat. pura appl.* (4), **35,** 59–90 (1953)] and it has been shown that the transverse components of **H** are defined by an equation of the form

$$\frac{\partial^2\chi}{\partial t^2} = a^2\frac{\partial^3\chi}{\partial t\partial z^2} + V^2\frac{\partial^2\chi}{\partial z^2}$$

with $a^2 = 1/\mu\gamma$, $V^2 = \mu H_0^2/\delta$. The conditions for a solution of the form $\chi = F(Vt - z) + a^2 f_1(z, t) + a^4 f_2(z, t, a)$, with $f_2(z, t, a)$ finite, are investigated and the physical significance of the solution is discussed for large values of γ. R. A. NEWING

538.563.08 : 621.317.784.029.6

7577. Automatic milliwattmeter for electromagnetic radiation. J. C. VAN DEN BOSCH AND F. BRUIN. *Appl. sci. Res. B,* **3,** *No.* 4–5, 260–4 (1953).

The instrument, which uses a thermistor, has two ranges, 1 and 10 mW full scale and is self-balancing and direct-reading. It is intended for routine measurement of power in the 1–10 cm range. A.

538.565 : 621.372.413 : 621.317.42

7578. A simple method for measuring the electromagnetic field distribution in a resonant cavity. A. SEPTIER. *C.R. Acad. Sci.* [*Paris*] **238,** 658–60 (*Feb.* 8, 1954) *In French.*

A perturbation method for the measurement of field components in resonant cavities based on "Slater's theorem." G. D. SIMS

538.566 : 532.5

7579. On the reflection and refraction of Alfvén waves. V. C. A. FERRARO. *Astrophys. J.,* **119,** 393–406 (*March*, 1954).

It is shown that plane harmonic hydromagnetic waves polarized at right angles to the plane of incidence can be reflected and refracted from a plane surface of separation of two infinitely conducting liquids. The general laws of reflection and refraction are derived, and it is shown that these depend on the orientation of the permanent uniform magnetic field with respect to the surface of separation and the plane of incidence. The propagation of hydromagnetic waves in a horizontally stratified isothermal atmosphere lying over an infinitely conducting liquid is briefly discussed. It is shown that eventually the magnetic field associated with waves decreases with height proportionately to the density of the atmosphere. A.

538.566 : 537.533.9

7580. Electrodynamics of the gyrotropic medium. A. A. KOLOMENSKIĬ. *Zh. éksper. teor. Fiz.,* **24,** *No.* 2, 167–76 (1953) *In Russian.*

See also Abstr. 2493 (1954). The propagation of electronic radiation in gyrotropic media (media in which normal electromagnetic waves have, in general, an elliptic polarization) is analysed using the generalized Hamilton method. Equations and formulae are developed for: potentials in the gyrotropic medium, energy of radiation, radiation of an electron moving with constant velocity in a gyrotropic medium, and radiation of an oscillator. F. LACHMAN

538.566 : 621.396.674

7581. Electromagnetic field of a dipole source above a ground dielectric slab. Y. T. LO. *J. appl. Phys.,* **25,** 733–40 (*June*, 1954).

A theoretical investigation has been made by integral transforms. The solutions in integral form have been evaluated asymptotically for distant field. It is found that the fields consist of a space wave and a surface wave. The former, spherical in nature, predominates in the free space, while the latter, cylindrical in nature and with a finite number of modes, is guided along the dielectric. As a result of the existence of at least one pole of the integrand, this surface wave always exists. At the dielectric surface, the zero-order spherical wave has a null value except in the case of critical thickness; then it should be referred to the next-order solution. A.

538.566 : 538.561 : 537.525.8

Electromagnetic properties of plasmas in a magnetic field. *See Abstr.* 7471

538.566 : 535.417

Theory and application of high resolution interferometers. *See Abstr.* 7333–5

538.566 : 621.396.11

7582. Diffraction of 3·2 cm electromagnetic waves by cylindrical objects. S. T. Wiles and A. B. McLay. *Canad. J. Phys.*, **32**, 372–80 (*June*, 1954).

Diffraction patterns of a brass tube and a hard rubber rod, each a cylinder of 1 in. diameter, in a nearly plane beam of square-wave modulated 3 cm waves with electric vector parallel to the cylinder axis, have been measured in several planes transverse to the incident beam direction. Experimental results for the conducting cylinder agree closely with calculations based on scalar diffraction theory. Patterns of the dielectric rod show a pronounced central peak immediately behind the rod and other intensity effects differing from the conducting cylinder patterns, particularly in the vicinity of the shadow. A.

538.566

7583. On the representation of the electromagnetic field in a waveguide with absorbing walls. M. De Socio. *R.C. Accad. Naz. Lincei*, **16**, 63–8 (*Jan.*, 1954) *In Italian.*

It is proved that, for the case of propagation between two parallel planes, the field may be represented by the superposition of two criss-cross evanescent waves. L. PINCHERLE

538.566 : 538.632 : 621.315.59 : 621.317.38

7584. The application of the Hall effect in a semi-conductor to the measurement of power in an electromagnetic field. H. E. M. Barlow. *Instn Elect. Engrs Paper* 1654, 7 *pp.* [To be published also in *Proc. Instn Elect. Engrs*].

Deals with the application of the Hall effect in a semi-conductor, like Ge, to measure the power transmitted along a line or a hollow metal waveguide. It is shown that the expression for the instantaneous value of the Hall e.m.f. generated in a small piece of semi-conductor erected in an electromagnetic field is of exactly the same form as the expression for the instantaneous power traversing the semi-conductor. Thus the mean value in time of the Hall e.m.f. is a direct measure of the power, and this is true for alternating, pulsating or steady fields. The paper describes various types of wattmeter embodying the foregoing principle and applied to a wide range of frequencies. The method is particularly suitable for use when strong magnetic fields are available, and heavy-current systems consequently lend themselves to the application of this device without the need for current transformers. Experiments at 50 c/s and again at 300 Mc/s with an *n*-type Ge crystal erected in the annular space between the inner and outer conductors of a coaxial line showed that, for a given power, the Hall e.m.f. was the same at the two frequencies, within the accuracy of the measurement. Thus there is a prospect of calibrating such an instrument at a low frequency and using it, if desired, at a very high frequency. A.

538.566 : 621.396.11 : 621.372.8

7585. Propagation of microwaves between a parallel pair of doubly curved conducting surfaces. K. S. Kunz. *J. appl. Phys.*, **25**, 642–53 (*May*, 1954).

Microwaves propagated between two doubly curved parallel conducting surfaces, in the geometrical optics approximation, follow rays obeying Fermat's principle. The optical distance in this case is determined both by the index of refraction of the material between the surfaces and by the curvature of the surfaces. The focusing properties of such a parallel plate lens is fully specified by giving the metric of the two-dimensional optical space associated with the mean surface of the guide. A family of equivalent lenses is shown to exist, and formulae are obtained that permit one to go from any one of these lenses to any other. Furthermore, conditions are given for there to exist in a family of equivalent lenses a lens employing a unit index of refraction everywhere. Of particular interest is the demonstration that the Rinehart analogue of the Luneberg lens and the RCA "R-2R" lens are members of a two-parameter family of lenses with analogous focusing properties. A.

538.566.3 : 621.396.11

7586. Effects of nonlinear properties of the ionosphere on radiowaves. I. M. Vilenskiĭ. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 3, 525–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-200.

A mathematical treatment of the effects of the perturbation of a nonlinear ionosphere by strong radiowaves on the waves themselves. The changes in amplitude and phase of the original wave can be considerable, and, in the case of an amplitude-modulated wave, there is also a change in modulation depth and the appearance of higher harmonics of the modulation frequency. G. M. BROWN

538.566.3 : 621.396.11

7587. The application of high-frequency radio-propagation predictions in the New Zealand area. G. McK. Allcock. *New Zealand J. Sci. Technol. B*, **35**, 198–212 (*Sept.*, 1953).

Skip times of 9·15 Mc/s radiowaves over an 800 km path were recorded for a period of 14 months. The results are compared with predictions supplied by overseas organizations. It is deduced that most of the differences between predictions and observations of maximum usable frequency (m.u.f.) are due to the use of an incorrect equation relating the m.u.f. for 800 km and 3000 km; an empirical equation is derived which replaces the incorrect equation. It is also shown that the frequency separation between m.u.f. for the ordinary wave and extraordinary wave $\simeq \frac{1}{2}$ (gyro-frequency). A.

MAGNETIC EFFECTS 538.6

538.614

7588. Influence of the paramagnetic resonance on the Faraday effect: discussion of an example. G. Paquette. *J. Phys. Radium*, **15**, 255–8 (*April*, 1954) *In French.*

The theory of Opechowski [Abstr. 8597 (1953)] is applied to $NiSiF_6 . 6H_2O$ to predict the change of Faraday effect when the salt is subjected to a high intensity (1–100 gauss) microwave field. The change has a maximum at each of the two resonance peaks of 20% or 0·7° at 3 cm and 1·9°K. D. H. WHIFFEN

538.614 : 538.083.9

7589. Use of the Faraday effect for the measurement of magnetic fields. F. Hock. *Z. angew. Phys.*, **6**, *No.* 4, 151–6 (1954) *In German.*

Describes measurements of the rotation of the plane of polarization in transparent iron films (530 Å thick) with the purpose of determining the magnetic field strength (up to 10^4 oersted) of a magnetic lens system. Comparison is made with the results of induction measurements. E. P. WOHLFARTH

538.63 : 537.311.33

Solution of the field problem of the germanium gyrator. *See Abstr.* 7418

538.63 : 538.66 : 536.7

7590. Thermodynamical theory of galvanomagnetic and thermomagnetic phenomena. II. Reciprocal relations for moving anisotropic mixtures. R. Fieschi, S. R. de Groot, P. Mazur and J. Vlieger. *Physica*, **20**, 245–58 (*May*, 1954).

For Pt I, see Abstr. 5826 (1954). The extension of Onsager's theory of reciprocal relations between irreversible processes, developed by De Groot and Mazur, is applied to heat conduction, diffusion and cross-effects and to viscosity in anisotropic mixtures of charged components in an electromagnetic field. Reciprocal relations are derived for these phenomena. A.

538.63 : 538.66 : 536.7

7591. Thermodynamical theory of galvanomagnetic and thermomagnetic phenomena. III. Explicit expressions for the measurable effects in isotropic metals. R. Fieschi, S. R. De Groot and P. Mazur. *Physica*, **20**, 259–73 (*May*, 1954).

The influence of the thermoelectric effects on the measurable coefficients of the galvanomagnetic and thermomagnetic effects is given here. The resulting additions to the local coefficients usually given and the relations among them are worked out explicitly. Besides the ordinary effects, longitudinal effects in a longitudinal magnetic field and Peltier effects in a transversal and longitudinal field are also considered. The second Thomson relation remains valid in a magnetic field. A.

538.632

7592. Measurement of Hall effect in cylinders without external magnetic field. G. Busch and R. Jaggi. *Z. angew. Math. Phys.*, **4**, *No.* 6, 425–33 (1953) *In German.*

A current flowing through a cylindrical conductor gives rise to a Hall effect due to its own magnetic field. A simple method for measuring the direct current and alternating current Hall voltages is described. Results of measurements consistent with conventional determinations of Hall coefficients are given for polycrystalline samples of bismuth at temperatures of 77°K and 290°K. A.

538.639

7593. New galvanomagnetic effect. C. Goldberg and R. E. Davis. *Phys. Rev.*, **94**, 1121–5 (*June* 1, 1954).

A galvanomagnetic effect is described which is observed by measuring the induced voltage normal to the direction of current flow as in the Hall effect but with the magnetic field in the current-voltage plane. The measurements enable the assumptions of spherical energy surfaces and spherical relaxation time surfaces for semiconductors to be tested. If these assumptions are correct, the effect should be isotropic. Preliminary room temperature measurements show this effect to be anisotropic in both *p*- and *n*-type germanium, in agreement with magnetoresistance measurements. A.

538.652

7594. Magnetostriction constants of silicon steel. E. Tatsumoto. *J. Sci. Hiroshima Univ. A*, **16**, 97–100 (*July*, 1952).

Reports measurements of λ_{100} for single crystal specimens (1·23% Si), obtaining the value $22{\cdot}5\times10^{-6}$. E. P. WOHLFARTH

538.652

7595. Magnetostriction of narrow single crystal plates of silicon steel. E. Tatsumoto. *J. Sci. Hiroshima Univ. A*, **16**, 117–26 (*July*, 1952).

A continuation of previous work [Abstr. 1186 (1951); and preceding abstr.]. The effect of externally applied tension on magnetostriction was investigated for various orientations. The value $-15{\cdot}5\times10^{-6}$ was obtained for λ_{111}. E. P. WOHLFARTH

538.652

7596. The approach to saturation magnetostriction. E. W. Lee. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 381–3 (*April*, 1954).

Shows that the procedure of obtaining the value of the saturation magnetostriction using the formula $\delta l/l = A + BH^{-1}$ is not valid if the magnetostriction is close to being isotropic, when a term in H^{-2} is important. E. P. WOHLFARTH

538.652 : 621.318.1

7597. A new magnetostrictive material. H. E. Stauss and G. Sandoz. Letter in *J. appl. Phys.*, **25**, 267 (*Feb.*, 1954).

Flakes of electrolytic iron were incorporated in a solid rubbery matrix to the extent of 50%. A block of this material increased in length by 8×10^{-5} cm/cm in an applied magnetic field of 3600 oersteds. The magnetostriction of the individual particles at saturation would have been $0{\cdot}4\times10^{-5}$ cm/cm. It is not certain whether the effect was a true magnetostriction phenomenon or the result of an attraction across the gap between the magnet pole face and the specimen surface. A. E. DE BARR

538.653.11

7598. The variation of the permeability of iron and steel with applied tension. J. Creusot. *C.R. Acad. Sci.* [*Paris*] **238**, 1203–4 (*March* 15, 1954) *In French.*

Describes measurements of the magnetic induction in wire specimens under the action of a fixed magnetic field and different applied tensions T. Under certain circumstances the induction remains constant for $T_1 < T < T_2$, T_1 and T_2 being characteristic of the specimens. E. P. WOHLFARTH

538.653.12

7599. Some new magneto-mechanical torsion experiments. A. W. Cochardt. *J. appl. Phys.*, **25**, 670–3 (*May*, 1954).

The internal damping of ferromagnetic wires was

measured as a function of either a superimposed static stress or an alternating magnetic field. Similar to a static magnetic field, a static stress affects the damping considerably. For example, the logarithmic decrement of a Fe-40% Co wire in torsional vibration is reduced by a factor of 33 when a heavy weight is suspended on the wire. The effect of an alternating magnetic field on the damping was studied by varying the frequency of the field. It is found that the damping reaches a strong minimum at a field frequency of the order of magnitude of 20 c/s. Magnetic hysteresis loss measurements were made which explain this phenomenon in terms of magneto-mechanical hysteresis. A.

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

7600. Atomic theory for students of metallurgy. W. HUME-ROTHERY. 2nd ed. *London: Institute of Metals* (1952) 331 *pp.*

Review in *Nature* [*London*] **173**, 924 (*May* 15, 1954).

539.11

7601. Rotation in solid mixtures of neohexane and cyclopentane from 20°K to their melting points. J. G. ASTON, B. BOLGER, R. TRAMBARULO AND H. SEGALL. *J. chem. Phys.*, **22**, 460–3 (*March*, 1954).

Studies of the broadening of the proton spin resonance line have been made for solid solutions of neohexane and cyclopentane. A convenient apparatus for control of temperatures from 10°K to room temperature for such studies is described. The "complex" of one mole of neohexane with two moles of cyclopentane rotates in the solid state down to 65°K. In solid solutions with cyclopentane in excess of the complex, the complex rotates independently of the cyclopentane down to 66°K. The complex has no effect on the lower rotational transition of the cyclopentane which apparently nucleates. A.

539.11 : 535.345–15

Infrared properties of metals and the mean free paths of conduction electrons. *See Abstr.* 7315

539.11 : 548.7

7602. Solution of the Schrödinger equation in periodic lattices with an application to metallic lithium. W. KOHN AND N. ROSTOKER. *Phys. Rev.*, **94**, 1111–20 (*June* 1, 1954).

The problem of solving the Schrödinger equation in a periodic lattice is studied from the point of view of the variation-iteration method. This approach leads to a very compact scheme if the potential $V(r)$ is spherically symmetrical within the inscribed spheres of the atomic polyhedra and constant in the space between them. The band structure of the lattice is then determined by (1) geometrical structure constants, characteristic of the type of lattice, and (2) the logarithmic derivatives, at the surface of the inscribed sphere, of the s, p, d, . . . functions corresponding to $V(r)$. By far the greater part of the labour is involved in the calculation of (1), which needs to be done only once for each type of lattice; (2) can be obtained by numerical integration or directly from the atomic spectra. Although derived from a different point of view, this scheme turns out to be essentially equivalent to one proposed by Korringa on the basis of the theory of lattice interferences. The present paper also contains an application to the conduction band of metallic lithium. A.

539.11 : 548.7 : 537.122

7603. The effective mass of electrons in crystals and the Ehrenfest theorem. D. PFIRSCH AND E. SPENKE. *Z. Phys.*, **137**, *No.* 3, 309–12 (1954) *In German.*

It is shown that the usual expression for the ratio of the actual to the effective electronic mass represents only a time average, and should be amended by the addition of rapidly oscillating terms; for a wave packet these additional terms decay rapidly and may be neglected. E. P. WOHLFARTH

MOLECULAR STRUCTURE 539.13

539.13

7604. I_4: A charge-transfer molecular complex? H. MCCONNELL. Letter in *J. chem. Phys.*, **22**, 760–1 (*April*, 1954).

Since electron donor molecules with ionization potentials 8–11 eV can form complexes with the acceptor iodine, whilst I itself has an ionization potential of 9·41 eV, it is suggested that I_4 may exist as a self-intermolecular charge transfer complex. The absorption band in I vapour at 2670 Å can then be interpreted as a charge transfer band. Further, this mechanism may account for bands whose existence in solid I_2 has been predicted on the basis of the nuclear absorption spectrum of the solid.

A. J. TAYLOR

539.13

7605. Vibrational relaxation times in gases (three-dimensional treatment). R. N. SCHWARTZ AND K. F. HERZFELD. *J. chem. Phys.*, **22**, 767–73 (*May*, 1954).

The calculations previously made by Schwartz, Slawsky, and Herzfeld [Abstr. 348 (1953)] are extended to three dimensions. As before, an exponential repulsion is fitted to the Lennard–Jones potential, with constants found from viscosity data. While the transition probability is determined directly by the short range repulsion forces, the attractive forces and the effect of the centrifugal quasi-potential modify the effective velocity of the colliding molecules. The agreement with experiment is fairly good, although high up on the repulsion curve (O_2, N_2) the Lennard–Jones 6–12 curve seems to be not quite steep enough. A.

539.13 : 532.7 : 534.22

Thermal relaxation of vibrational states in sulfur hexafluoride. *See Abstr.* 7196

539.13 : 533.7

7606. The intermolecular potentials for some simple nonpolar molecules. E. A. MASON AND W. E. RICE. *J. chem. Phys.*, **22**, 843–51 (*May*, 1954).

Experimental data on the crystal properties, second virial coefficients and viscosity coefficients of Ne, A, Kr, Xe, CH_4, N_2, CO, O_2 and CO_2 were analysed for the purpose of obtaining values of the parameters in the exp-six intermolecular potential,

$$\phi(r) = \frac{\varepsilon}{1 - 6/\alpha}\left[\frac{6}{\alpha}e^{\alpha(1-r/r_m)} - \left(\frac{r_m}{r}\right)^6\right]$$

For gases whose molecules are spherical, it was possible to reproduce, with a single set of potential parameters, not only the crystal, second virial, and viscosity data, but also data on other transport properties with fair accuracy. For gases whose molecules deviate appreciably from spherical symmetry it was necessary to choose at least two different sets of potential parameters in order to reproduce different types of properties. Such behaviour was taken to indicate the inadequacy of the assumptions, made in the fundamental gas theories, that intermolecular forces are central and that intermolecular collisions are elastic. A.

539.132

7607. The applications of wave mechanics to the study of the structure of molecules. *Paris: Editions de la Revue d'Optique* (1953), 223 *pp. In French.*

Review in *Proc. Phys. Soc.* [*London*] *A*, **67**, 483 (*May*, 1954). "This is a collection of some eleven lectures arranged in a series, and given under the general presidency of L. de Broglie in 1951. Some of the papers are essentially experimental, others entirely theoretical."

539.132

7608. Representation of the error by a potential and iterative solution of the Schrödinger equation. A. LAFORGUE. *C.R. Acad. Sci.* [*Paris*] **238**, 1033–5 (*March* 1, 1954) *In French.*

The approximate solution of the Schrödinger equation can be represented as exact solution of a related problem, the difference being expressed by the error potential. If this is bounded, a bound for the energy is also found; or, by perturbation, an energy correction can be calculated. J. JACOBS

539.132 : 535.33.07–14

Microwave spectroscopy. *See Abstr.* 7272

539.132

7609. Theoretical basis of Badger's rule for the force constant of molecules. Y. P. VARSHNI. *J. sci. industr. Res.*, **13 B**, 84–6 (*Feb.*, 1954).

Assuming that the valence electrons of a diatomic molecule form a Fermi gas and that the variations in the force constant are mostly due to changes in the repulsive force, Badger's relation, viz. $K_e(r_e - d_{ij})^3 =$ constant, has been shown to have a semi-theoretical justification for the different electronic states of a diatomic molecule. A.

539.132

7610. The electronegativities and some electron affinities of copper, zinc, and gallium subgroup elements. A. P. ALTSHULLER. Letter in *J. chem. Phys.*, **22**, 765 (*April*, 1954).

The electronegativities and hence electron affinities are calculated by the thermochemical method using the dissociation energies of the halides and hydrides. W. GOOD

539.132

7611. "Smoothed potential" theory of chemical binding. J. R. ARNOLD. Letter in *J. chem. Phys.*, **22**, 757–8 (*April*, 1954).

An attempt is made to deduce bond energies (except for bonds containing N, O, or F) from a quantum mechanical model in which the valence electrons are supposed to move in a simple potential (cylindrical square well or harmonic oscillator) which has a trough between the atoms. The two potentials lead to similar equations for the energies in terms of the bond lengths and atomic radii. Predicted and observed energies are tabulated for fifty different bonds. A. J. TAYLOR

539.132

7612. The determination of the potential constants of SO_2 from centrifugal distortion effects. D. KIVELSON. *J. chem. Phys.*, **22**, 904–8 (*May*, 1954).

The microwave spectrum of SO_2 was reanalysed with particular emphasis upon the effect of centrifugal distortion. It was possible to fit the rotational spectrum to within a mean deviation of $\pm 0{\cdot}23$ Mc/s using the energy expression given by Kivelson and Wilson. The rotational constants so determined are $a = 60778{\cdot}79$ Mc/s, $b = 10\,318{\cdot}10$ Mc/s, and $c = 8799{\cdot}96$ Mc/s. The four distortion constants could not be uniquely determined directly from the rotational spectrum. The sets of potential constants determined by Wilson and Polo were used to calculate distortion constants and these in turn used to calculate frequency shifts due to centrifugal distortion. These shifts are critically dependent upon the set of potential constants used. By choosing a set of potential constants compatible with the infrared spectrum which also yield distortion frequency shifts in accord with those obtained from a direct analysis of the rotational spectrum, a very sensitive determination of the potential constants may be made. The resulting force constants are: $f_d = 10{\cdot}006 \times 10^5$ dyne cm^{-1}; $f_\alpha/d_0^2 = 0{\cdot}7933 \times 10^5$ dyne cm^{-1}; $f_{dd} = 0{\cdot}0236 \times 10^5$ dyne cm^{-1}; $f_{d\alpha}/d_0 = 0{\cdot}189$ dyne cm^{-1}. A.

539.132 : 535.343.4–15

Infrared spectrum of $S^{16}O^{18}O$ and the potential constants of SO_2. *See Abstr.* 7309

539.132

7613. Attempt at the identification of the system of the molecule OH not identified by Schüler. S. BENOIST. *C.R. Acad. Sci.* [*Paris*] **238**, 883–5 (*Feb.* 22, 1954) *In French.*

Previously a mixture of D_2O and H_2O vapour, excited in a discharge tube, showed superposition of two types of spectra between 5500 and 4200 Å. A third spectrum (from HDO) was not observed, so it was concluded that the spectrum originated with either an OH or an OD group. Here the rotational structure of these bonds is analysed and the rotation constants are tabulated. Vibration constants and dissociation energies of the higher electronic levels were determined in order to classify the ultraviolet transition involved. A. J. TAYLOR

539.132

7614. The asymmetric rotator in quantum mechanics. C. VAN WINTER. *Physica*, **20**, 274–92 (*May*, 1954).

The methods of the existing literature on the subject are rearranged and supplemented in this general survey. With the symmetric rotator, the Hamiltonian H commutes with the component of angular momentum P_c along the symmetry axis of the rotator. The eigenfunctions of H prove to be identical with the simultaneous eigenfunctions Φ of the square of the angular momentum P^2, the component of angular momentum P_z along an axis fixed in space, and P_c. In the case of the asymmetric rotator, H does not commute with any component of angular momentum in a direction fixed in the rotator. The eigenfunctions of H may now be written as linear combinations of functions Φ. As a new method, instead of the Φ closely connected functions Φ^s are used, adapted to the four-group symmetry of the asymmetric rotator. The secular equation then splits immediately into four factors related to the four possible symmetry species of the eigenfunctions. The confusion resulting from the various choices of the phases of matrix elements and wave functions is cleared. Some algebraic properties important for calculating the energy values are treated. The position of the levels is illustrated by a diagram. The symmetry classification can be found from the sequential order of the eigenvalues, a result particularly important for practical application. In conclusion, the selection rules for dipole radiation are given. A.

539.132

7615. A theoretical evaluation of the normal frequencies of vibration of the ethylene oxide molecule. S. A. STONE. *J. chem. Phys.*, **22**, 925–7 (*May*, 1954).

A theoretical evaluation of the normal frequencies of vibration of the ethylene oxide molecule is made. The evaluation is accomplished by assuming a generalized valence force field containing twelve force constants. Values for two of the constants are assumed, and the values of the other ten are calculated so as to give values of the computed frequencies in good agreement with observed values. A.

539.132

7616. Rotational energy transfer in H_2. R. BROUT. *J. chem. Phys.*, **22**, 934–9 (*May*, 1954).

Rotational energy deactivation probabilities have been calculated for H_2 using the quantum-mechanical method of distorted waves. Approximate procedures have been indicated for further extensions of these calculations to other symmetric diatomic molecules. Comparison with data from sound dispersion measurements shows good agreement between theory and experiment. A.

539.132

7617. Bending fundamental of NO_2. M. BROWN AND M. K. WILSON. Letter in *J. chem. Phys.*, **22**, 955 (*May*, 1954).

The rotational constants of NO_2 and the band-centre for the bending fundamental ν_2 are determined from the absorption spectrum of NO_2 in the frequency range 640–920 cm^{-1}, measured at 175°c. The bending fundamental is analysed on the assumption that the structure of the NO_2 molecule approximates to a symmetric top. G. I. W. LLEWELYN

539.132 : 518.5

7618. The application of a high-speed digital computer to molecular vibration problems. D. E. MANN, L. FANO, W. F. CAHILL AND T. SHIMANOUCHI. Letter in *J. chem. Phys.*, **22**, 764 (*April*, 1954).

A code has been devised for the SEAC towards the solution of characteristic equations; by an iteration process the eigenvalues of 12th order matrices are found with great accuracy. Application has been made to planar and non-planar vibrations of ethylenes. Codes have also been developed for the calculations of force constants. J. JACOBS

539.132 : 535.33.07

Limitation to the precision of molecular constants determined with a diffraction grating. *See Abstr.* 7270

539.132

7619. On the functions of the self-consistent field in the case of *trans*-butadiene. C. MOSER. *C.R. Acad. Sci.* [*Paris*] **238**, 1585–7 (*April* 12, 1954) *In French.*

An empirical approximation which resembles that of Pariser and Parr, but ignores the H atoms. Using a single configuration, the energy of the lowest transition is close to the experimental value, while the first ionization potential is very high. The ground-state energy is below that obtained with the non-empirical S.C.F. method. J. JACOBS

539.132

7620. Properties of the hydrogen molecular ion. IV. Oscillator strengths of the transitions connecting the lowest even and lowest odd σ-states with higher σ-states. D. R. BATES, R. T. S. DARLING, S. C. HAWE AND A. L. STEWART. *Proc. Phys. Soc.* [*London*] *A*, **67**, 533–9 (*June*, 1954).

The oscillator strengths associated with the $1s\sigma_g$–$3p\sigma_u$, $1s\sigma_g$–$4p\sigma_u$, $1s\sigma_g$–$4f\sigma_u$, $2p\sigma_u$–$2s\sigma_g$, $2p\sigma_u$–$3s\sigma_g$ and $2p\sigma_u$–$3d\sigma_g$ transitions of H_2^+ are computed from the exact two-centre wave functions. It is found that some of the transition integrals vary rapidly with the internuclear separation. The significance of this in connection with the calculation of relative intensities in band systems is briefly discussed. A comparison is made with the values of the oscillator strengths obtained using the LCAO approximation. A.

539.132

7621. Deductions about hybridization from nuclear quadrupole coupling constants. P. N. SCHATZ. Letter in *J. chem. Phys.*, **22**, 755 (*April*, 1954).

Calculations based on a simple model of the Cl_2 molecule show that the observed value of the quadrupole coupling constant implies an $s-p$ hybrid bond with about 17% s character. Similar results are found with CH_3Cl and HCl. Physically the bonding charge-shift alters the field gradient at the nucleus. A. J. TAYLOR

539.132 : 541.57

7622. Sulfur bonds and the quandrupole moments of O, S, and Se isotopes. G. R. BIRD AND C. H. TOWNES. *Phys. Rev.*, **94**, 1203–8 (*June* 1, 1954).

Quadrupole couplings of S^{33} in HDS, SO_2 and CH_3SH have been measured. These and previously measured quadrupole couplings of S^{33} in OCS, HNCS, CS and S_8 are examined to determine the nature of sulphur bonds and the best value for the S^{33} quadrupole moment. $s-p$ hybridization is found to be common, but not universal, in sulphur

bonds. The S^{33} quadrupole moment is $-0{\cdot}064 \pm 0{\cdot}01 \times 10^{-24}$ cm^2. If O and Se bonds are assumed to be similar to those of S, the quadrupole moments of O^{17} and Se^{79} are $-0{\cdot}004 \times 10^{-24}$ cm^2 and $0{\cdot}9 \times 10^{-24}$ cm^2, respectively. A.

539.132

7623. Studies in molecular orbital theory of valence. III. Multiple bonds involving *d*-orbitals. H. H. JAFFÉ. *J. phys. Chem.*, **58**, 185–90 (*Feb.*, 1954).

For Pt II, see Abstr. 660 (1954). Multiple bonding involving both valence and penultimate electron shell *d*-orbitals has long been postulated. This paper discusses the construction of molecular orbitals for such multiple bonds from combination of $d\pi$- and hybrid $dp\pi$-orbitals with $p\pi$- and $d\pi$-orbitals, and from $d\delta$- with $d\delta$-orbitals, and illustrates the resulting MO's graphically. The symmetry and directional properties of *d*-orbitals are used to discuss conjugation by such multiple bonds of several radicals attached to a central atom in several geometric arrangements. Square planar and octahedral central atoms are found to permit conjugation of four and six radicals, respectively. Tetrahedral central atoms on the other hand are seen to permit conjugation only at the expense of appreciable multiple bonding energy. Hence it is concluded that unequal radicals will enter into effective competition for the *d*-orbitals of the central atom. This conclusion explains the apparently contradictory findings in attempts to demonstrate conjugation in compounds such as sulphones. Finally it is concluded that multiple bonding involving valence shell *d*-orbitals can be important only if the central atom carries a positive charge in the single bonded structures. A.

539.132

7624. Study of the action of light on a molecule of spirane type by the method of linear combination of atomic orbitals. J.-L. MASSE. *C.R. Acad. Sci.* [*Paris*] **238**, 1320–2 (*March* 22, 1954) *In French.*

Under normal conditions these molecules exist in equilibrium in planar and non-planar forms. It had been suggested that excitation by visible light increases the importance of the planar form. This is verified by LCAO calculations showing the bond 7–8 to be nearly single in the excited state, which would allow rotation about this bond. J. JACOBS

539.132

7625. The possible existence of a reduced potential energy function for diatomic molecules. A. A. FROST AND B. MUSULIN. *J. Amer. Chem. Soc.*, **76**, 2045–8 (*April* 20, 1954).

A reduced potential energy is defined as V/D_e where V is the potential energy, taking the zero for infinite separation of the nuclei. A reduced internuclear distance is defined as $(R - R_{ij})/(R_e - R_{ij})$ where R is the actual internuclear distance, R_e the equilibrium distance and R_{ij} a constant for a given molecule formed from atoms i and j. It is shown that there exists an approximate universal relation, in the neighbourhood of the minimum, between these variables for the ground states of a set of 23 diatomic molecules, chosen only for the accuracy of their experimental data. R_{ij} is interpreted as a measure of inner shell radii and is closely correlated with Badger's d_{ij}. A.

539.132

7626. The resonance energy of graphite. G. M. BARROW. Letter in *J. chem. Phys.*, **22**, 953 (*May*, 1954).

Agreement of MO theory [Wheland (1934)] with experiment is much improved by taking into account, in calculation of the "experimental" value of the resonance energy, of the branched-chain effect on the heat of formation of hydrocarbons. Using Mulliken and Parr's empirical formula [Abstr. 438 (1952)] for this, and with an estimate of 2 kcal/gm atom for the energy needed to separate the layers to an "ideal gas state," the value 10 kcal/gm atom is obtained for the resonance energy of graphite. MO theory gives $0{\cdot}58\beta$, thus $\beta = 17$. Similar calculations for benzene give 36 kcal/mole, $2{\cdot}00\beta$, and thus $\beta = 18$, removing the former discrepancy. The resonance energy per carbon atom is thus larger for graphite than for simple polynuclear aromatic molecules. J. HAWGOOD

539.132

7627. Approximate molecular orbitals. II. The $2p\pi_u$ and $3d\pi_g$ states of H_2^+. B. L. MOISEIWITSCH AND A. L. STEWART. *Proc. Phys. Soc.* [*London*] *A*, **67**, 457–63 (*May*, 1954).

For Pt I, see Abstr. 6789 (1954). The variational method is used to obtain approximate wave functions for the $2p\pi_u$ and $3d\pi_g$ states of H_2^+. Their accuracy is assessed by comparing the values of various quantities computed from them with the corresponding values computed from the exact wave functions. The dependence of the total kinetic and potential energies on the nuclear separation is briefly discussed. A.

539.132

7628. Approximation of molecular orbitals in diatomic molecules by diatomic orbitals. R. F. WALLIS AND H. M. HULBURT. *J. chem. Phys.*, **22**, 774–81 (*May*, 1954).

The constants necessary for the specification of the exact wave functions of the homonuclear one-electron diatomic molecule have been tabulated for a range of relatively large internuclear distances. A method for determining upper and lower bounds of the constants is presented. The energy of the hydrogen molecule has been calculated for the ground state using the one-electron two-centre wave functions as molecular orbitals. The results of a similar calculation by Hylleraas have been confirmed and extended. It is found that the best results are obtained if the effective nuclear charges for the molecular orbital of one electron are different from the effective nuclear charges for the molecular orbital of the second electron. Somewhat less satisfactory results are obtained if the effective nuclear charges are the same in both orbitals. The application of diatomic orbitals in the calculation of the properties of other diatomic molecules is discussed. Calculations of energy appear to be prohibitively laborious; calculations of electric dipole moments and transition probabilities may be feasible. A.

539.132 : 517.4

7629. A property of "repeating" secular determinants. H. O. PRITCHARD AND F. H. SUMNER. *Phil. Mag.*, **45**, 466–70 (*May*, 1954).

A special type of secular determinant is encountered

in the molecular orbital treatment of second-order hyperconjugation in normal paraffin molecules. For such a determinant, the sum of the positive roots is a linear function of the number of rows in the determinant, to an accuracy which is usually better than one part in 10^5. A.

539.132

7630. On the electronic structure of nitrobenzene. M. SIMONETTA AND A. VACIAGO. *Nuovo Cimento*, **11**, 596–606 (*June*, 1954) *In Italian.*

A molecular orbital treatment of the nitrobenzene molecule is given: dipole moment, u.v. absorption frequency, electronic densities, bond orders, free valences, resonance energy have been calculated with a reasonable choice of the parameters involved and with good agreement with experimental data. The kinetic behaviour of the molecule in all types of substitutions is also correctly predicted: the chemical non-crossing rule is verified. A.

539.132 : 535.343–31

7631. Study of the spectra of methylpyrenes by the method of linear combination of molecular orbitals. J.-L. MASSE. *C.R. Acad. Sci.* [*Paris*] **238**, 1226–9 (*March* 15, 1954) *In French.*

The effect of methylation on the u.v. spectrum is investigated. The methyl is treated as diatomic: a C atom and the H_3 group behaving as one atom; it is therefore characterized by a single parameter. The calculated and experimental values for first absorption wavelengths are in good agreement; the λ-variations obeying the additivity rule. J. JACOBS

539.132

7632. Conversion of *ortho-* to *para*-hydrogen in the liquid phase. G. L. SQUIRES AND A. T. STEWART. Letter in *J. chem. Phys.*, **22**, 754 (*April*, 1954).

The heat evolved in the spontaneous conversion of ortho- to para-hydrogen increases the rate of evaporation of the liquid. To avoid this the hydrogen is catalytically converted into the para form by the joint action of charcoal and oxygen, in an apparatus which is described. The half-life τ for conversion was found to be 10–20 min in presence, and 18 hr in absence, of oxygen. Swenson's figure $\tau = 25$ min [Abstr. 6793 (1950)] in *absence* of oxygen is possibly explained by his charcoal having been inadvertently exposed to air. S. J. GREGG

539.132

7633. The C–C bond dissociation energies in cyclanes. H. O. PRITCHARD AND A. F. TROTMAN-DICKENSON. Letter in *J. chem. Phys.*, **22**, 944–5 (*May*, 1954).

Criticism of work of Seubold [Abstr. 644 (1954)]. His assumption that activation energy for the formation of the cyclane from the coiled diradical is zero is unjustifiable, as an unknown energy of straining the bond angles may be involved, there being no evidence that the bond is "broken" (attraction $\sim kT$) at a tetrahedral C–C–C angle. No diradicals can be detected by addition of toluene to the isomerization reaction of cyclopropane to propylene (activation energy 65 kcal/mole, $\log A = 15{\cdot}17$); it is unlikely that $\log A < 13$ for the diradical process, so a lower limit of 65 must be placed on D(C–C), whereas Seubold gives 50. J. HAWGOOD

539.132

7634. Carbon-carbon bond dissociation energies in the cycloalkanes. F. H. SEUBOLD, JR. Letter in *J. chem. Phys.*, **22**, 945–6 (*May*, 1954).

Reply to criticisms (see preceding abstract). The assumption of zero activation energy for cyclization is defended; studies of the photolysis of methyl cyclopropyl and cyclobutyl ketones show that trimethylene radicals cyclize and rearrange with similar rates, and that D(C–C) is less for C_3 than for C_4. In the isomerization of cyclopropane, 65 kcal/mole is not necessarily a lower limit to D(C–C), as the diradical process may well have $\log A < 13$, so despite a lower activation energy could be outweighed by the quasi-unimolecular process. There is a 7 kcal/mole barrier for attack of methyl radicals on toluene, which will therefore be outweighed by the exothermic rearrangements, so non-detection of radicals is not decisive. New results for D(C–H) entail revised values for D(C–C); 57 for C_3, to 94 for C_9. J. HAWGOOD

539.133 : 535.343.4–14

Dipole moment of pyridine. *See Abstr.* 7306

539.133 : 535.343.4–14

Structure of CH_2ClF. *See Abstr.* 7305

539.133 : 548.737

Molecular structure of fluorene. *See Abstr.* 7897

ATOMIC STRUCTURE . NUCLEUS
ISOTOPES 539.15

539.152.1

7635. Introduction to nuclear physics [Einführung in die Kernphysik]. W. RIEZLER. 5th ed. *Munich: R. Oldenbourg* (1953) 332 *pp. In German.*

Review in *Acta phys. Austriaca*, **8**, *No.* 3, 319 (1954) *In German.*

539.152.1

7636. Nuclear physics. W. HEISENBERG. *New York: Philosophical Library* (1953) 225 + ix *pp.*

Review in *Rev. sci. Instrum.*, **25**, 380–1 (*April*, 1954).

539.152.1

7637. Nuclear theory. R. G. SACHS. *Cambridge, Massachusetts: Addison Wesley Publishing Company* (1953) 383 + xi *pp.*

Review in *Amer. J. Phys.*, **22**, 347–8 (*May*, 1954).

539.152.1

7638. Collective and individual-particle aspects of nuclear structure. A. BOHR AND B. R. MOTTELSON. *K. Danske Vidensk. Selsk., mat.-fys. Medd.*, **27**, *No.* 16, 174 *pp.* (1953).

A unified nuclear model incorporating both individual-particle and collective features has already been discussed [Abstr. 4524 (1952), in which for **27** in line 3 read **26**; Abstr. 3522 (1953)]. According to this the nucleus can be described as a shell structure capable of performing oscillations in shape and size, which involve variations of the nuclear field and are therefore strongly coupled to the particle motion. The model is further developed, especially in relation to ground-state and low-energy properties, and the available empirical evidence concerning spins, magnetic movements and quadrupole moments is analysed on this

basis. The low-energy level structure, arising from the interplay of the particle and collective types of excitation, is discussed, and important evidence on the interpretation of nuclear excitations is obtained from the analysis of γ- and β-transitions. In an appendix a description of nuclear reactions is formulated on the assumption that the formation of the compound nucleus is initiated by the interaction of the incident particle with the surface oscillations of the target nucleus. The scattering cross-sections are considered for various strengths of the coupling. A sum rule for the scattering widths of the resonance levels is discussed. Another appendix discusses the excitation of rotational levels by means of the electric field of impinging particles, with special reference to the electromagnetic radiative transitions of the excited nucleus. W. J. SWIATECKI

539.152.1

7639. Intermediate coupling calculations in the unified nuclear model. D. C. CHOUDHURY. *K. Danske Vidensk. Selsk., mat.-fys. Medd.*, **28**, *No.* 4, 13 *pp.* (1954).

The intermediate coupling treatment discussed by Bohr and Mottelson (preceding abstract) is extended to a study of the nuclear level structure for a single $j = 5/2$ particle coupled to the nuclear surface oscillations of the quadrupole type. Magnetic moments and quadrupole moments for the nuclear ground states for $j = 5/2$ and $j = 7/2$ configurations are also considered. Wave functions are used, including all unperturbed states with up to three phonons, and the energies and moments are calculated as a function of the coupling strength. The inclusion of states with still more phonons would be needed to make detailed contact with the strong-coupling region. However, even for the intermediate coupling strength for which the present results are valid, various features of the strongly coupled system are beginning to develop. A.

539.152.1

7640. Some singularities in the distribution of the isotopes of atomic nuclei. V. I. MAMASAKHLISOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 190–6 (1953) *In Russian.*

The question of the existence of α-particles in the nuclei is reconsidered in the light of recent data on the collisions of fast particles with the nucleus, pointing to the possibility of existence of the individual nucleus parts. The known facts—viz. that, beyond N, (1) nuclei with an odd Z (atomic number) have either one stable isotope or, at most, two such isotopes differing by 2 neutrons, and (2) all nuclei with an odd charge have an odd mass number, whereas those with an even charge have both the even and odd mass numbers—are given a tentative explanation based on the assumption that, when the addition of a nucleon to a stable nucleus is accompanied by the known processes β^+, β^- or K-capture, an internal change of structure, accompanied by the formation of α-particles, can take place in the nucleus. The existence of adjacent isotopes for Li, B and N, and their absence from F^{19} onwards, find also an explanation, as well as the fact that, in a system of stable isotopes with even Z, those isotopes are absent that would be obtained from the $(Z - 1)$ nuclei by the $n \rightarrow p$ change. The proposed model of the distribution of the neutron and proton states tallies with data available for the known stable isotopes. F. LACHMAN

539.152.1

7641. The energy surface and the stability of heavy nuclei. V. A. KRAVTSOV. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 242–4 (1953) *In Russian.*

Constructs the surface $E = f(Z, A)$ representing the dependence of the binding energy of nucleons on the atomic number and mass number. The surface has a "hollow" at Pb^{208}, which lies at the intersection of two "grooves" along the lines $Z = 82$ and $N = 126$. F. LACHMAN

539.152.1

7642. Nuclear shells. V. A. KRAVTSOV. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 244–6 (1953) *In Russian.*

See preceding abstract. Analyses the "energy surface" sections by different (even and odd) A planes. The six regions of high-stability nuclei found experimentally around Si^{28}, Ni^{62}, Sr^{88}, Sn^{120}, Ce^{140} and Pb^{208} have the form of two "grooves" intersecting at the above six "hollows." F. LACHMAN

539.152.1

7643. On the ground state of the deuteron. Y. TAKANO. *Sci. Rep. Yokohama Nat. Univ. I*, *No.* 2, 16–17 (*March*, 1953).

With use of the usual S_{12} coupling, and a square well potential, series are found for the S and D components of the deuteron ground state. G. E. BROWN

539.152.1

7644. The surface of a nucleus. J. M. C. SCOTT. *Phil. Mag.*, **45**, 441–65 (*May*, 1954).

In interpreting experiments on nuclear reactions, a common procedure includes the use of a "radius" of the form $r_0 A^{1/3}$ or $r_0(A_1^{1/3} + A_2^{1/3})$, with $r_0 = 14 \cdot 5 \times 10^{-14}$ cm. Certain recent experiments indicate a rather high density of nuclear matter, and imply that r_0 is 20% smaller than this; but whereas some nuclear reaction data also suggest a smaller radius, others seem to require a larger one. With the object of improving this situation, a theoretical analysis of neutron scattering data is given which yields information on the form of the outermost part of the nuclear field. Using the hypothesis of charge-independence, the field affecting protons is deduced from that affecting neutrons. The potential barrier calculated in this way for protons is much less severe when the energy is near the top of the barrier than it would be on the customary assumption of a sharp nuclear boundary. Approximate formulae for the penetrability are given for limiting cases. The neutron data are found to be difficult to reconcile with two-body nuclear forces with the conventional Yukawa shape, but are consistent with any of the short-tailed potentials. A.

539.152.1

7645. Many-particle configurations in a central field. C. SCHWARTZ AND A. DE-SHALIT. *Phys. Rev.*, **94**, 1257–66 (*June* 1, 1954).

Closed formulas are obtained for the fractional parentage coefficients of j-j coupled configurations of three and four equivalent particles. In states of low

seniority, these formulas can be used to simplify the calculation of familiar types of matrix elements. Some extension is made to the study of more complex configurations. In particular, it is shown that near the ground state the energy level spectrum of an even-even nucleus should be independent of the number of particles in the unfilled shell. A.

539.152.1

7646. Level densities in heavy nuclei of 10- to 20-MeV excitation. D. B. BEARD. Letter in *Phys. Rev.*, **94**, 738–9 (*May* 1, 1954).

Nuclear temperatures are calculated allowing for the variation with excitation energy of the number of nucleons taking part in the excitation. The results are in better agreement with experiment than those of the usual theory. P. T. MATTHEWS

539.152.1

7647. Statistical factors in radiation widths of nuclear energy levels. D. J. HUGHES. Letter in *Phys. Rev.*, **94**, 740–1 (*May* 1, 1954).

A review of the statistical factors which are involved in the comparison of experimental results on level widths with the theory. P. T. MATTHEWS

539.152.1 : 539.174

7648. Internal conversion electrons from Coulomb excited Ta and W. T. HUUS AND J. H. BJERREGAARD. Letter in *Phys. Rev.*, **92**, 1579–81 (*Dec.* 15, 1953).

The stable isotopes of tantalum and tungsten have been excited to low-lying nuclear levels by bombardment with 2 MeV protons. The excitation is caused by the Coulomb field since particles of such low energy cannot penetrate the Coulomb barrier. Information concerning the levels involved is obtained by studying the energy spectra of the internal-conversion electrons produced when the excited nuclei decay. Transitions of energies 137 keV and 166 keV (error in energies $<1\%$) are found in Ta^{181}, both being almost pure (85%) type $M1$. These data are consistent with the first two levels of Ta^{181} being at 137 and 303 keV with probable spins of 9/2 and 11/2 respectively, and parities the same as that of the ground state. From the relative intensities of the transitions the magnetic moment of Ta^{181} is found to be 2·8 nuclear magnetons. In tungsten three transitions, all of type $E2$, are observed. Of these, a line at 124 keV is assigned to W^{186}, and lines at 102 and 113 keV are attributed tentatively to W^{182} and W^{184} respectively. D. R. CHICK

539.152.1 : 539.174

7649. Electric excitation of low-lying levels in separated wolfram isotopes. C. L. MCCLELLAND, H. MARK AND C. GOODMAN. Letter in *Phys. Rev.*, **93**, 904 (*Feb.* 15, 1954).

Scintillation-counter analysis of γ's emitted after excitation of 2+ rotational levels with 2·5 MeV protons on enriched samples of $W^{182, 183, 184, 186}$ gives the respective energies as 101, 103, 112, 124 (± 4) keV. The relative intensities of the even isotopes are consistent with the theory of Bohr and Mottelson [Abstr. 7638 (1954)]. W. J. SWIATECKI

539.152.1 : 539.174

7650. Electric excitation of tantalum. J. T. EISINGER, C. F. COOK AND C. M. CLASS. Letter in *Phys. Rev.*, **94**, 735–6 (*May* 1, 1954).

A scintillation spectrometer has been used to study the intensities and angular distributions of the 139, 167 and 309 keV γ-rays produced when tantalum is bombarded by 3 MeV protons. The results are consistent with a rotational nuclear model. J. J. WILKINS

539.152.2

7651. High polarization of nuclei in paramagnetic substances. P. BROVETTO AND G. CINI. *Nuovo Cimento*, **11**, 618–25 (*June*, 1954).

A thermodynamical treatment of nuclear polarization in paramagnetic solids is developed. The general validity of the results obtained by Overhauser [Abstr. 1565 (1954)] for alkali metals, is confirmed. It is found possible to achieve a degree of nuclear polarization equal to the one obtainable with the same magnetic field and temperature for electrons. A.

539.152.2

7652. Magnetic moment of K^{40} in intermediate coupling. G. E. TAUBER AND T.-Y. WU. *Phys. Rev.*, **94**, 1307–10 (*June* 1, 1954).

The K^{40} nucleus is of interest since its spin $I = 4$ forms a notable exception to Nordheim's rule while the observed value $\mu = -1{\cdot}29\,\mu_N$ for the magnetic moment seems to favour the $j - j$ coupling. The theory of intermediate coupling is applied to the configuration $d^{-1}f$ with the view of accounting for the spin and the observed magnetic moment. It is found that a small spin-orbit interaction will lead to a negative magnetic moment. A central nucleon-nucleon interaction of the form $(mP + nQ)V(r_{12})$, where P denotes the Majorana and Q the Bartlett operator, is assumed and calculations have been carried out for the exponential, Yukawa and Gaussian types of potential $V(r_{12})$ with various "ranges." For a suitable choice of the spin-orbit interaction parameter ζ, the observed magnetic moment can be obtained, the exact value of ζ depending on the type of potential and range used. A.

539.152.2

7653. Spins of the lowest states of the K^{40}, P^{32} and Al^{28} nuclei. H. A. ENGE. Letter in *Phys. Rev.*, **94**, 730–1 (*May* 1, 1954).

When the lowest states of spin I of a nucleus are all members of the same closely spaced (j, j) multiplet the relative excitation of these states in the (d, p) reaction will depend principally on a statistical factor $2I + 1$. The values of the reaction yield at 90° relative to that of the ground state have been used to determine I of these states. M. A. GRACE

539.152.2 : 535.338.332

7654. Nuclear spin of Am^{243} and isotope shift in the americium spectrum. J. G. CONWAY AND R. D. MCLAUGHLIN. Letter in *Phys. Rev.*, **94**, 498 (*April* 15, 1954).

The hyperfine structure obtained with a grating has 6 components like that of Am^{241}, showing spin 5/2 and same magnetic moment. Wavelengths and isotope shifts (with respect to Am^{241}) of 28 lines are listed. W. J. SWIATECKI

539.152.2

7655. Preliminary results with Purcell's bridge technique of nuclear resonance. T. P. DAS AND D. K. RAY. *Sci. and Culture*, **19**, 464–6 (*March*, 1954).

539.152.2

7656. Nuclear relaxation in an alternating field. C. MANUS, R. MERCIER, P. DENIS, G. BÉNÉ AND R. EXTERMANN. *C.R. Acad. Sci.* [*Paris*] **238**, 1315–16 (*March* 22, 1954) *In French.*

The size of a nuclear induction signal varies with the frequency of the alternating magnetic field, which replaces the usual static field, in such a way that the relaxation time T_1 can be obtained. The effect is modified by a phenomenon related to spin echoes. D. H. WHIFFEN

539.152.2

7657. Line-narrowing by macroscopic motion. F. BLOCH. Letter in *Phys. Rev.*, **94**, 496 (*April* 15, 1954).

Although practical magnets of 7000 gauss have field inhomogeneities of about 1 milligauss, resolution of nuclear induction signals of less than this can be obtained by mechanical motion of the sample at speeds about 10 cm/sec, so that the field inhomogeneities are effectively averaged. See abstract following. D. H. WHIFFEN

539.152.2

7658. A line-narrowing experiment. W. A. ANDERSON AND J. T. ARNOLD. Letter in *Phys. Rev.*, **94**, 497 (*April* 15, 1954).

Following Bloch's suggestion (preceding abstract) the proton resonance signal in a H_2O sample has been narrowed from $1{\cdot}7\times10^{-3}$ to 10^{-4} in half-width by rotation of the sample at 25 rev/sec. A corresponding increase of peak strength of 7 times is obtained. D. H. WHIFFEN

539.153 : 535.338.333

7659. Theory of the isotope shift of spectral lines. I. I. GOL'DMAN. *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 177–89 (1953) *In Russian.*

Discusses the isotope shift in atomic spectra, due to differences in mass and size of nuclei. It is demonstrated that the discrepancy between theory and experiment, particularly large for the middle elements of the periodic system, can be eliminated if allowance is made for the interaction between the optical electron and the internal electrons of the atom. The recent experimental data of the isotope shift in Cu, Zn, Rb, Ag, Cd and Ba are analysed by means of approximate formulae developed by the author. The results enable the trend in the size of nuclear radii for the isotopes of these elements to be assessed, and the interaction between an electron and a neutron to be estimated as $b < 4\times10^{-45}$ erg cm^3. E. LACHMAN

539.153 : 538.222

7660. On the problem of resonances between several levels in an ensemble of oriented atoms. C. BESSET, J. HOROWITZ, A. MESSIAH AND J. WINTER. *J. Phys. Radium*, **15**, 251–5 (*April*, 1954) *In French.*

A theoretical discussion of the transition probabilities in a system of three energy levels subject to a periodic perturbation of high-intensity electromagnetic radiation. Besides the usual allowed transitions $1\rightarrow2$, $2\rightarrow3$, transitions $1\rightarrow3$ are possible with the correct frequency even though matrix elements only connect adjacent states directly. The $1\rightarrow3$ transitions are narrower in frequency range and depend on a higher power of the perturbation field. Generalization to more levels shows that $1\rightarrow4$ and higher transitions are possible and should be even narrower and depend on yet higher powers of the field strength. The theory completely explains the experiments on Na atoms of Brossel, Cagnac and Kastler [Abstr. 3296 (1954); see also Abstr. 4730 (1954)]. D. H. WHIFFEN

539.153.4

7661. Electronic wave functions. XI. A calculation of eight variational wave functions for Cl, Cl^-, S and S^-. S. F. BOYS AND V. E. PRICE. *Phil. Trans A*, **246**, *No.* 917, 451–62 (1954).

For Pt X, see Abstr. 4968 (1953). The variational co-detor method has been applied to calculate wave functions and energies for the P^2 and S^2 states of Cl, the S^1 state of Cl^-, the P^3, D^1, S^1 and P_0^3 states of S and the P^2 state of S^-. This is the first application of the method to atoms of the second chemical period, and is thus an application to considerably more complicated circumstances than have been previously examined. Except for the wave functions of the P^2 state of Cl and the S^1 state of Cl^- there are no records of any previous approximations of comparable accuracy to these wave functions, and no comparable predictions for any of the energy values. The introduction of relativistic corrections has been investigated and incorporated in this calculation. It was also found possible to adapt several sections of the calculation to the automatic calculating machine, the EDSAC, which has performed a considerable amount of the computation. A.

539.153.4

7662. Electronic wave functions. XII. The evaluation of the general vector-coupling coefficients by automatic computation. S. F. BOYS AND R. C. SAHNI. *Phil. Trans A*, **246**, *No.* 917, 463–79 (1954).

A considerable number of different types of investigations on atomic and nuclear wave functions involve the use of vector-coupled functions and would be facilitated by an easy method of evaluation of the basic fundamental coefficients. This is particularly so for the present series of investigations, in which very complicated vector-coupled functions are used in convergent methods of atomic wave-function calculation. Hitherto the evaluation of these coefficients, which are independent of all aspects of a problem other than the irreducible representations of the rotational group concerned, has been extremely tedious while still requiring considerable mathematical understanding. It has now been found possible to develop a method of calculation which can be performed purely automatically by the EDSAC, proceeding from the lowest argument values indefinitely through all higher values. A substantial table, which would otherwise require over a year of computation by a mathematician, has been obtained. This investigation constitutes a significant contribution to problems of wave-function calculation and also involves some minor innovations in the vector-coupling theory. A.

539.153.4

7663. Extended Thomas–Fermi methods. R. A. BALLINGER AND N. H. MARCH. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 378–81 (*April*, 1954).

A method of Plaskett [Abstr. 3534 (1953)] and an

old method of Weizsäcker are applied to improve the Thomas–Fermi field in the case of a linear oscillator, the first ten levels of which are occupied. A degree of arbitrariness exists in the former theory; one particular solution reproduces the exact density well, but no criterion is found for choosing the appropriate solution. The Weizsäcker theory does not improve the Thomas–Fermi theory appreciably. The method of Plaskett would be cumbersome to apply to atoms. G. E. BROWN

539.155

7664. Atomic masses in the intermediate region. T. L. COLLINS, W. H. JOHNSON, JR AND A. O. NIER. *Phys. Rev.*, **94**, 398–404 (*April* 15, 1954).

The double-focusing mass spectrometer previously described [Abstr. 6837 (1953)] has been used to measure 28 atomic masses in the region between gallium and niobium. The new information combined with previous determinations permits one to draw a rather complete packing fraction curve for the region from sulphur through xenon. Analysis shows that masses for stable and unstable isotopes of an element can be fitted by parabolas, one for odd A and one for even A. The two parabolas have the same shape (except just above a proton shell), but are displaced in A as well as mass. The displacements are such that, for an isobar, the minimum mass does not occur at the same Z for the four nuclear families (even even, etc.), in contradiction to usual assumptions. A.

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16

7665. Radioactivity and radioactive substances. J. CHADWICK. 4th ed. *London: Sir Isaac Pitman and Sons* (1953) xv + 120 *pp*.

Review in *Nature* [*London*] **173**, 933 (*May* 15, 1954).

539.16.08

7666. Use of Callendar's "radio-balance" for the measurement of the energy emission from radioactive sources. W. B. MANN. *J. Res. Nat. Bur. Stand.*, **52**, 177–84 (*April*, 1954).

In 1910 H. L. Callendar described a calorimeter for measurement of radiant energy in which the quantity of heat to be measured is balanced against the cooling from a Peltier couple. He called this thermal-balance device a "radio-balance." The operation of the radio-balance has been extensively investigated to see whether it could be used for the accurate determination of the energy emission from radioactive sources. In the present experiments, measurements have been confined solely to radium preparations. For an absorption equivalent to 0·126 cm of lead a heat emission of $128{\cdot}9\ \text{cal g}^{-1}\ \text{hr}^{-1}$ has been found for radium in equilibrium with its products down to radium D. The estimated accuracy of this result is ±0·7%. A.

539.16.08

7667. The effects of finite size and decentring of the source in an angular correlation experiment. E. BREITENBERGER. *Phil. Mag.*, **45**, 497–504 (*May*, 1954).

In a first approximation any extended source behaves like a point source situated at the "centre of gravity" of the given activity distribution. The first-order errors caused by bad centring of a point source are rather large and exhibit a strong angular dependence. They can be minimized by a randomized block design when it is impossible to avoid them altogether owing to technical reasons. Numerical formulae are given for the rapid estimation of first- and second-order errors. The relations between source decentring and angular resolution of the detectors are examined. The approximation method used in this study can be adapted to other problems (e.g. angular distributions, scattering experiments). A.

539.16.08

7668. Bubble tracks in a hydrogen-filled Glaser chamber. J. G. WOOD. Letter in *Phys. Rev.*, **94**, 731 (*May* 1, 1954).

Superheated liquid H_2 boils sooner in the presence of a γ-ray source [see Abstr. 1592 (1954)]. Here the bubble chamber is immersed in a bath of H_2 which boils at a high pressure, providing a pressure-controlled heat reservoir. The technique is outlined and a bubble track photograph given. D. V. MABBS

539.16.08 : 612.014.483

7669. The radioactivity of the human being. A. T. KREBS. *Science*, **119**, 429–31 (*April* 2, 1954).

Results of published values are tabulated and discussed. It is shown that measuring methods which include counting of α-rays give higher values, since they record radioactive substances other than Ra element alone. D. V. MABBS

539.162

7670. Occurrence of the $(4n + 1)$ series in nature. D. F. PEPPARD, G. W. MASON, P. R. GRAY AND J. F. MECH. *J. Amer. Chem. Soc.*, **74**, 6081–4 (*Dec.* 5, 1952).

A small quantity of Np^{237}, the long-lived ancestor of the $4n + 1$ series, has been isolated from a natural source. The Th^{229} content of Th^{230} obtained from Belgian Congo pitchblende concentrate and of Th^{232} obtained from Brazilian monazite has been determined indirectly through isolation of the Ac^{225} daughter. The respective values for the mass ratio Th^{229} to Th^{232} in these sources is $(4{\cdot}0 \pm 0{\cdot}6) \times 10^{-11}$ and less than 3×10^{-14}. The mass ratio of U^{233} to U^{238} in the pitchblende concentrate and the monazite samples is set at $(1{\cdot}3 \pm 0{\cdot}2) \times 10^{-13}$ and less than $(4 \pm 2) \times 10^{-11}$, respectively. The maximum value for the mass ratio of Np^{237} to U^{238} in the Belgian Congo pitchblende concentrate is thus calculated to be $(1{\cdot}8 \pm 0{\cdot}4 \times 10^{-12}$, and the maximum value for the ratio of the respective neutron capture cross-sections of U^{238} in the ore body for the $(n, 2n)$ and (n, γ) reactions is set at $(1{\cdot}3 \pm 0{\cdot}6) \times 10^{-3}$. It is probable that the true values are much lower than these figures which are based on the assumption of zero contribution from the $Th^{232}(n, \gamma)$ reaction. The relative contributions of the $U^{238}(n, 2n)$ and the $Th^{232}(n, \gamma)$ reactions cannot be calculated, but it seems likely that the latter reaction makes the larger contribution. A.

539.162

7671. The angular correlation of three nuclear radiations. G. R. SATCHLER. *Phys. Rev.*, **94**, 1304–6 (*June* 1, 1954).

An angular correlation formula for any three nuclear radiations is given, including the effects of other intermediate radiations which are not observed. Emission from aligned nuclei is also covered. Application to nuclear reactions is considered. In particular the correlation formula is given for γ-rays following inelastic neutron scattering when continuum theory is applied to the compound nucleus state. A.

539.163

7672. Contribution to the study of polonium sources. M. ADER. Letter in *J. Phys. Radium*, **15**, 191 (*March*, 1954) *In French.*

The long-range particles emitted with low frequency from polonium sources can be due to either a fine structure of the polonium nucleus or to the spontaneous fission of polonium. In the latter case the long-range particles could correspond to the α-particles observed in the tripartition of uranium. [See also Abstr. 4867 (1954).] A. C. COATES

539.163

7673. The decay of ^{203}Hg, ^{203}Pb and ^{201}Pb. A. H. WAPSTRA, D. MAEDER, G. J. NIJGH AND L. T. M. ORNSTEIN. *Physica*, **20**, 169–77 (*March*, 1954).

Hg^{203} and Pb^{203} have been studied with scintillation and β-ray spectrometers. The transitions to the Tl^{203} ground states are absent in both; both decay to a 279 ± 1 keV state in Tl^{203}($\alpha_K = 0{\cdot}141 \pm 0{\cdot}015$, $K/L = 3{\cdot}30 \pm 0{\cdot}10$, $L/(M+N) = 3{\cdot}45 \pm 0{\cdot}3$; $E_2 + M_1$). In Pb^{203} 5·1% of the nuclei decay to a 679 ± 2 keV state in Tl^{203}, which emits for 4·3% a 400 ± 2 keV γ-ray ($\alpha_K = 0{\cdot}118 \pm 0{\cdot}015$, $K/L = 6{\cdot}0 \pm 0{\cdot}4$, $L/(M+N) = 4{\cdot}5 \pm 0{\cdot}7$; $E_2 + M_1$) and for 0·8% a 678 ± 3 keV γ-ray ($\alpha_K = 0{\cdot}009 \pm 0{\cdot}003$, E_2). The maximum energy of the Hg^{203} β-spectrum is 219 ± 10 keV. In Pb^{201} a 325 keV transition ($K/(L+M) = 5 \pm 1{\cdot}5$) and a 583 keV transition were found; the half-life was $8{\cdot}4 \pm 1$ hr. A.

539.163

7674. On the particles of great range emitted by polonium, thorium and uranium. M. ADER. *C.R. Acad. Sci.* [*Paris*] **238**, 1215–16 (*March* 15, 1954) *In French.*

The photographic method used to detect long-range particles from Po [Abstr. 4867 (1954)] shows that similar particles are emitted by thorium. Grain counting on 500 tracks suggests that these are α-particles. M. A. GRACE

539.163

7675. Additional properties of isotopes of elements 99 and 100. P. R. FIELDS, M. H. STUDIER, J. F. MECH, H. DIAMOND, A. M. FRIEDMAN, L. B. MAGNUSSEN AND J. R. HUIZENGA. Letter in *Phys. Rev.*, **94**, 209–10 (*April* 1, 1954).

Element 99^{253}, a $6{\cdot}61 \pm 0{\cdot}01$ MeV α-emitter of $19{\cdot}3 \pm 0{\cdot}3$ days $\frac{1}{2}$-life, which had been separated by ion-exchange methods from pile irradiated Pu [Abstr. 6870 (1954)] was irradiated with pile neutrons. This led to the formation of 99^{254}, a β^--emitter of 37 ± 1 hr $\frac{1}{2}$-life, and 100^{254}, a $7{\cdot}17 \pm 0{\cdot}01$ MeV α-emitter of $3{\cdot}3 \pm 0{\cdot}2$ hr $\frac{1}{2}$-life which also decays by spontaneous fission (1/1600 ± 300 disintegrations). M. A. GRACE

539.163

7676. Nuclide V^{53}. R. K. SHELINE AND J. R. WILKINSON. Letter in *Phys. Rev.*, **94**, 729–30 (*May* 1, 1954).

V^{53} produced by $Cr^{53}(n, p)$ reaction using pile neutrons and a 92% Cr^{53} sample, decays by β-decay ($E_{max} = 0{\cdot}56 \pm 0{\cdot}1$ MeV) and a complex γ-ray spectrum with a 23 ± 1 hr $\frac{1}{2}$-life. M. A. GRACE

539.163.1

7677. Spontaneous fission of uranium. H. LU AND H.-L. TSAO. *Acta Sci. Sinica*, **1**, 77–84 (*Oct.*, 1952).

An attempt has been made to determine the half-life for spontaneous fission for the "average uranium atom" with an argon-filled parallel-plate ionization chamber, employing the method of electron collection. A simple method of analysing and extrapolating the observed fission counts from uranium deposits of various thicknesses has yielded the value $(4{\cdot}2 \pm 0{\cdot}6) \times 10^{16}$ years for this half-life. The mean range of fission fragments in uranium oxide is thereby found to be about 7·5 mg of uranium per cm^2. A.

539.163.1

7678. The half-life of U^{232}. P. A. SELLERS, C. M. STEVENS AND M. H. STUDIER. *Phys. Rev.*, **94**, 952 (*May* 15, 1954).

The half-life of U^{232} has been determined to be $73{\cdot}6 \pm 1{\cdot}0$ years by a method involving isotopic dilution, mass spectrometric analysis and the determination of the specific activity of the diluted sample by conventional weighing and counting techniques. A.

539.163.1

7679. Search for a possible error in the measured half life of Au^{198}. R. E. BELL AND L. YAFFE. *Canad. J. Phys.*, **32**, 416–18 (*June*, 1954).

The half-life was measured using a quartz fibre electroscope, with extreme precautions against errors due to the presence of Au^{199} in the source. The result obtained, $2{\cdot}699 \pm 0{\cdot}003$ days, shows that other recent determinations of the Au^{198} half-life do not suffer an appreciable error from this cause. A.

539.163.2

7680. Application of electromagnetic isotope separation to the study of the 390 keV isomeric transition of technetium. R. BERNAS, J. BEYDON AND L. PAPINEAU. *C.R. Acad. Sci.* [*Paris*] **238**, 791–3 (*Feb.* 15, 1954) *In French.*

A Mo target was bombarded with 6·7 MeV deuterons and after chemical treatment the Tc isotopes were separated electromagnetically. Scintillation counter and β-spectrometer measurements showed that the 390 keV γ-radiation (44 min $\frac{1}{2}$-life) was associated with the Tc^{93} fraction. M. A. GRACE

539.163.2

7681. Decay scheme of Xe^{135}. S. THULIN. Letter in *Phys. Rev.*, **94**, 734–5 (*May* 1, 1954).

The β- and γ-spectra of Xe^{135} were studied by means of coincidence measurements on electromagnetically separated Xe^{135} samples in an intermediate-image β-spectrometer. A decay scheme is proposed. A. O. STANESBY

539.163.2

7682. Neutron-deficient activities of holmium. T. H. HANDLEY. *Phys. Rev.*, **94**, 945–6 (*May* 15, 1954).

Proton bombardment of pure oxides of Dy, Ho and Er has served to clear up some uncertainties concerning neutron-deficient activities of Ho. Two previously reported activities, 5·2 day and 65 day, were not found, and reassignment of the 5·0 hour activity to a mass of 162 is made. The γ-ray spectrum of the 5·0 hour activity shows it to decay by electron capture with γ-energies of 0·19, 0·71 and 0·95 MeV; 41-minute Ho^{164} is shown to decay by electron capture and by β^--emission. A.

539.163.2

7683. Manganese-57. B. L. COHEN, R. A. CHARPIE, T. H. HANDLEY AND E. L. OLSON. *Phys. Rev.*, **94**, 953–4 (*May* 15, 1954).

A previously unknown isotope, 1·7 minute Mn^{57}, was produced by an (n, p) reaction on isotopically enriched Fe^{57}. It was identified by chemical separations, by measurement of its formation cross-section, by investigation of possible impurity effects and by comparison of its γ-spectrum with that of Co^{57}. It decays principally by 2·6 MeV negatron emission to the 131 keV excited state of Fe^{57}, which in turn decays to either the ground or the 14 keV state of Fe^{57} with approximately equal probability. The γ-ray spectrum also indicates the presence of a weak 690 keV γ-ray, and possible weak γ-rays of 350 keV and 220 keV. It is shown that a previous assignment of a 7·2 day activity to Mn^{57} is very probably in error. A.

539.163.2

7684. Radiations of 53-min I^{134} and 86-sec I^{136}. M. MCKEOWN AND S. KATKOFF. *Phys. Rev.*, **94**, 965–7 (*May* 15, 1954).

The radiations were examined with a scintillation spectrometer and compared with known radiations. The former was found to emit β-rays of $1·5 \pm 0·1$ MeV and $2·5 \pm 0·2$ MeV maximum energy, and γ-rays of the following energies: $0·86 \pm 0·01$ MeV, $1·10 \pm 0·03$ MeV and $1·78 \pm 0·05$ MeV. Coincidence measurements showed that the 2·5 MeV β-rays were followed by the 0·86 MeV γ-rays and that the first excited level in Xe^{134} is very likely at 0·86 MeV as predicted by the systematics of even-even nuclei. There is some evidence for two additional weak γ-rays at 120 keV and 200 keV. The I^{136} was found to decay by emission of a β-ray branch of $6·3 \pm 0·3$ MeV maximum energy leading to the ground state of Xe^{136}, a $5·0 \pm 0·3$ MeV β-ray branch followed by $1·38 \pm 0·05$ MeV γ-rays, and a $3·7 \pm 0·2$ MeV β-ray branch followed by $2·9 \pm 0·2$ MeV γ-rays. A possible disintegration scheme is proposed. The first excited state at 1·38 MeV corresponds to that expected for the 82-neutron closed-shell nucleus, Xe^{136}. A.

539.163.2

7685. Ytterbium-167. T. H. HANDLEY AND E. L. OLSON. *Phys. Rev.*, **94**, 968–9 (*May* 15, 1954).

Proton bombardment of pure Tm_2O_3, followed by ion-exchange separations, has yielded an activity with an 18·5 min half-life. Determination of the excitation function and identification of the daughter Tm^{167} assigns the activity to Yb^{167}. A γ-ray spectrum shows it to decay by electron capture with a 0·118 MeV and possibly other γ-rays. A.

539.163.2

7686. The decay of ^{207}Bi and the energy levels of ^{207}Pb. J. R. PRESCOTT. *Proc. Phys. Soc.* [*London*] *A*, **67**, 540–52 (*June*, 1954).

The electron-capture decay of Bi^{207} has been studied by scintillation counter coincidence techniques. γ-rays of energy 0·57, 1·07, 1·76 and 2·47 MeV were found in the relative abundances 1·57 : 1 : 0·16 : 0·0072. "Prompt" coincidences were observed between the three former and the K-capture X-ray. The following percentages of the γ-rays were prompt: 0·57 : 19%; 1·07 : 6%; 1·76 : 7%. There is some evidence for a prompt γ-ray of 1·46 MeV. The 1·76 and 1·07 MeV γ-rays are in coincidence with the 0·57 MeV γ-ray. The results are discussed in relation to the level scheme of Pb^{207}. A.

539.163.2

7687. Radiations of AcK. E. K. HYDE. *Phys. Rev.*, **94**, 1221–6 (*June* 1, 1954).

The γ-rays of AcK (Fr^{223}) were studied in a sodium iodide photomultiplier scintillation counter coupled to a 50-channel pulse height analyser. Photons of a 49·8 keV γ-ray appear in $40 \pm 10\%$ and photons of an 80 keV γ-ray appear in $24 \pm 6\%$ of the total β-disintegrations. In addition, low-intensity γ-rays appear at 215 and 310 keV. L X-radiation is present in about the same intensity as the 49·8 keV γ-ray. γ-γ coincidence studies proved that the 49·8 and 80 keV radiations were not in coincidence. It was also shown that the 215 and the 50 keV γ-rays are not in coincidence. The L X-radiation was studied in a proportional counter coupled to a 50-channel analyser and identified as radium X-rays. Since Th^{227} decays to the same daughter as does AcK some measurements were made on its γ-spectrum. Prominent photopeaks were observed at 49·8, 87 and 235 keV. The 235 and 49·8 keV γ-rays were observed to be in coincidence. The known decay data for AcK and Th^{227} cannot be fitted into a common decay scheme without additional information. A.

539.163.2

7688. Alpha-emitting isomer: polonium 211. F. N. SPIESS. *Phys. Rev.*, **94**, 1292–9 (*June* 1, 1954).

The half-life of AcC′ (Po^{211}) has been measured for the first time, and is 0·52 sec rather than the 1/200 sec widely quoted in the literature. Three short-lived α-emitters resulting from α-particle bombardment of lead have been studied. They have been identified as Bi^{211} ($T_{\frac{1}{2}} = 2·16$ min) and two states of Po^{211} ($T_{\frac{1}{2}} = 25$ sec and 0·52 sec) by means of chemical separations, excitation functions, half-life measurements, and measurements of the energies of the emitted α-particles. The energy measurements show that the 0·52 sec state is an excited state of Po^{211}, with an excitation energy of about 0·3 MeV. A group of α-particles having about 9 MeV energy was observed but not identified. A.

539.164 : 539.155.4

7689. Application of Fermi's atomic mass formula to the estimation of alpha-disintegration energy in the rare earth region. G. P. DUBE AND L. S. SINGH. Letter in *Curr. Sci.*, **23**, 84–5 (*March*, 1954).

An empirical correction ($\Delta m = 0·0185 - 2$

$[0{\cdot}0002\,A^{1{\cdot}2} - 0{\cdot}00014\,Z^{1{\cdot}5}]$ mass units) to the semi-empirical atomic-mass formula of Fermi is put forward and, using it, the α-stability of some of the rare-earth nuclides is discussed. A. O. STANESBY

539.165

7690. Self-absorption phenomena in the measurement of the radioactivity of nickel-63. G. K. SCHWEITZER, B. R. STEIN AND J. W. NEHLS. *J. phys. Chem.*, **56**, 692–3 (*June*, 1952).

The self-absorption characteristics of nickel-63 are quite regular, behaving as would be predicted from self-absorption data on other low-energy β-emitters. Two methods of sample preparation seem to yield good results, that of electroplating and that of precipitation of nickel dimethylglyoxime. An average mass absorption coefficient of $1{\cdot}48$ cm^2/mg has been observed. A.

539.165

7691. Lens spectrometer study of the disintegration of ^{233}Pa. W. D. BRODIE. *Proc. Phys. Soc.* [*London*] *A*, **67**, 397–412 (*May*, 1954).

The electron spectrum of Pa^{233} was studied over the energy range 4 keV to 570 keV. The energies of the observed conversion lines agree well with those (19 keV and over) of Keller and Cork [Abstr. 1280 (1951)] and confirm the existence of the weak 272 keV γ-ray. The low-energy spectrum includes *L*-conversion lines of the $28{\cdot}7$ keV γ-ray, and *M*, *N* and *O* conversions of the predicted $17{\cdot}2$ keV γ-ray. The main part of the continuum consists of three partial spectra with end-points at 568 ± 5, 256 ± 4 and 140 ± 14 keV, and intensities of 5, 57 and 38% respectively. A decay scheme is proposed which requires that the partial spectrum of lowest energy is a close doublet. Pa^{233} yields a total of $2{\cdot}0 \pm 0{\cdot}15$ electrons of 4 keV and over per disintegration. A.

539.165

7692. Effect of atomic electron screening on the shape of forbidden beta spectra. R. H. GOOD, JR. *Phys. Rev.*, **94**, 931–3 (*May* 15, 1954).

In Fermi's theory of β-decay the influence of the atomic electrons on the shape of the spectra is often disregarded since the influence is small except at low energies. However, there is some interest in knowing exactly how small it is. This paper gives an approximate calculation of the screening effect, both for allowed and for forbidden spectra. The Thomas–Fermi model for the atomic electrons and WKB approximations for the wave functions of the emitted particles are used. The results for the allowed spectra agree with those of Rose and of Longmire and Brown. The calculations for the forbidden spectra lead to a simple rule for finding the screening effect in any specific case. A.

539.165.2

7693. Nuclear shell model *ft* values for intermediate coupling. R. SCHULTEN AND R. A. FERRELL. Letter in *Phys. Rev.*, **94**, 739 (*May* 1, 1954).

Using wavefunctions already calculated [Abstr. 4845 (1954)], the β-decay matrix elements and thus the *ft* values are evaluated for several light nuclei. The results agree satisfactorily with experiment and indicate intermediate coupling. P. T. MATTHEWS

539.165.2

7694. First-forbidden matrix elements in β decay. R. W. KING AND D. C. PEASLEE. *Phys. Rev.*, **94**, 1284–92 (*June* 1, 1954).

An assumed form for the linear combination in β-decay ($S - T + \lambda_P P$), is used as a tool to explore the features of nuclear structure revealed by first-forbidden matrix elements. The assumptions made are sufficient to account for the observed fact that most first-forbidden transitions have $\log ft$ values centring around $6{\cdot}5$, $7{\cdot}5$ and $8{\cdot}5$, according as $\Delta I = 0$, 1 or 2. The squared matrix elements are reduced by an order of magnitude (i) when configuration mixing occurs, as in the usual, "unfavoured" transitions, in contrast to the "favoured" transitions around $A = 208$; (ii) when the single-particle spin change Δj predicted by the shell model exceeds the nuclear spin change ΔI. From (i) and (ii) it is concluded that the elementary form of the shell model specifies individual particle orbitals with good accuracy but that configuration mixing is also of major importance, although it is not encompassed by the simple shell model. The $2^- \rightarrow 2^+$ transitions can be classified under (ii); their apparently straight spectra should average on the order of 10% α type. The only consistent interpretation of the RaE decay is as a $1^- \rightarrow 0^+$ transition; it is possible to predict that this kind of spectrum is unlikely to occur at any other mass number *A*. Evidence for the presence of the pseudoscalar interaction *P* in the linear combination is then provided by the low *ft* values of $\Delta I = 0$ transitions. A.

539.165.2

7695. Mixed double disintegration–capture processes. N. N. KOLESNIKOV. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 246–7 (1953) *In Russian.*

See Abstr. 7515 (1952). Develops a theory without neutrinos for the double mixed disintegration–absorption processes β^+K and β^-K. F. LACHMAN

539.165.2

7696. Variation of electron wave functions inside the nucleus. Application to β transitions. R. NATAF. *C.R. Acad. Sci.* [*Paris*] **238**, 1117–20 (*March* 8, 1954) *In French.*

The influence of the variations calculated in [Abstr. 6804 (1954)] on the β-decay matrix elements is estimated for allowed and forbidden transitions ($0{\cdot}7$–12% and ~20% respectively). W. J. SWIATECKI

539.166

7697. A photon monochromator for bremsstrahlung radiation. J. GOLDEMBERG. Letter in *Phys. Rev.*, **93**, 1426 (*March* 15, 1954).

The apparatus described is similar to that used by Weil and McDaniel [Abstr. 1721 (1954)]. The extracted electron beam of a 22 MeV betatron falls on a gold foil. Degraded electrons from the foil are analysed magnetically and are detected in coincidence with the corresponding photon. The resolution achieved is $\pm 0{\cdot}2$ MeV. J. J. WILKINS

539.166

7698. On the γ-rays emitted by Ba^{133}_{77}. M. LANGEVIN. *C.R. Acad. Sci.* [*Paris*] **238**, 1310–12 (*March* 22, 1954) *In French.*

Measurements with a scintillation spectrometer

established γ-rays of energies 73, 81·5, 290 and 363 keV. A decay scheme is suggested. J. J. WILKINS

539.166

7699. Radiative electron capture in Fe^{55}. L. MADANSKY AND F. RASETTI. *Phys. Rev.*, **94**, 407–8 (*April* 15, 1954).

The internal bremsstrahlung emitted in electron capture by Fe^{55} was studied from 14 keV to the upper energy limit at 220 keV. Fair agreement with the formula of Morrison and Schiff (1940) is observed at high energies, whereas a strong rise of the intensity occurs at low energies. The discrepancy may be due to failure of the theory to take into account the effects of nuclear charge, capture of p electrons and forbiddenness of the transition. A.

539.166

7700. Angular distribution of photoelectrons from gamma radiation of 0·4 and 1·3 MeV. A. HEDGRAN AND S. HULTBERG. Letter in *Phys. Rev.*, **94**, 498 (*April* 15, 1954).

The angular distribution of photoelectrons from a lead radiator, measured over the range 0° to 60° with a β-spectrometer, showed intensity maxima at 24° for 0·4 MeV and at 12° for 1·3 MeV radiation.

M. A. GRACE

539.166 : 539.172.11

7701. Gamma rays from Li^7, F^{19}, Ne^{22}, and Na^{22} produced by alpha-particle bombardment of lithium and fluorine. N. P. HEYDENBURG AND G. M. TEMMER. *Phys. Rev.*, **94**, 1252–7 (*June* 1, 1954).

The study of the γ-radiation following the inelastic scattering of α-particles in thin fluorine and lithium targets has led to the discovery of new levels in the compound nuclei Na^{23} and B^{11}. The (α, p) and (α, n) reactions in F^{19} have led to the establishment of the 1·28 MeV level as first-excited state of Ne^{22}, and the discovery of the first-excited state ($T = 1$, $I = 0^+$) of Na^{22} respectively. Coulomb excitation is believed to be responsible for the low-energy part of the excitation function of the 196 keV second-excited state in F^{19}, whereas this effect is much weaker for the 113 keV first-excited state of F^{19}. No capture γ-rays exist above the known resonance at 0·958 MeV in the reaction $Li^7(\alpha, \gamma)B^{11}$. A.

539.166 : 539.172.13

7702. Scintillation counter study of gamma rays from proton capture in sodium. R. R. CARLSON, E. H. GEER AND E. B. NELSON. *Phys. Rev.*, **94**, 1311–16 (*June* 1, 1954).

The spectrum of the γ-rays produced by the resonant capture of 305 keV protons by sodium has been studied with a single-crystal scintillation spectrometer having a resolution of 21% at 6 MeV, and with a three-crystal scintillation pair spectrometer having a resolution of 7% at 6 MeV. γ-Rays of energies $10·61 \pm 0·05$ MeV, $7·9 \pm 0·2$ MeV, $6·7 \pm 0·2$ MeV, $4·2 \pm 0·1$ MeV and $1·38 \pm 0·03$ MeV were observed. Cascades were found from coincidence measurements. The energies of the γ-rays and cascades are consistent with transitions between known levels of Mg^{24}. The α-decay of the 11·99 MeV Mg^{24} state to the ground state of Ne^{20} has been observed to be much less probable than its γ-decay. The direct γ-transition of this state to the 0^+ ground state of Mg^{24} is absent. The angular distribution of the most energetic γ-ray is anisotropic. These results allow limitations to be placed on the spin and parity of the 11·99 MeV state in Mg^{24}. A.

539.166 : 539.172.4

7703. Gamma rays from the inelastic scattering of 14-MeV neutrons in C^{12} and O^{16}. L. C. THOMPSON AND J. R. RISSER. *Phys. Rev.*, **94**, 941–3 (*May* 15, 1954).

A NaI scintillation spectrometer has been used to study the γ-rays produced by the inelastic scattering of 14 MeV neutrons in carbon and oxygen. The scattering material was placed around the neutron source with the γ-ray detector outside the scatterer. A γ-ray from the 4·43 MeV level in C^{12} was obtained with a cross-section of about 0·3 barn. γ-Rays from the known level at 6·13 MeV and levels close to 7 MeV were obtained from O^{16} with a total cross-section of about 0·2 barn. A.

539.166.08

7704. The summation of γ-ray energies with a single-crystal spectrometer. D. C. LU AND M. L. WIEDENBECK. Letter in *Phys. Rev.*, **94**, 501–2 (*April* 15, 1954).

By placing the γ-ray source inside a sufficiently large (e.g. NaI(Tl) 2 in. dia.×2 in. thick) scintillation crystal, peaks were observed in the pulse-height spectrum corresponding to the energy summation of prompt cascade γ-rays. In certain cases (e.g. Pt^{192}) this can be used to decide between alternative disintegration schemes. A. O. STANESBY

539.166.83

7705. Internal conversion spectrum of the active deposit of radon. M. MLADJENOVIĆ AND H. SLÄTIS. *Ark. Fys.*, **8**, *Paper* 5, 65–82 (1954).

The energy and the intensity of Auger and internal conversion lines of the active deposit of radon were measured by means of a high-resolution permanent magnet β-ray spectrometer with photographic recording. Ellis results were generally confirmed. In addition, a number of new lines were found. For four prominent low-energy γ-rays, the L_{II} lines were resolved from L_I lines and their ratio measured. The multipole order of 53·23, 241·9, 295·2 and 352·0 keV γ-rays was established to be magnetic dipole with a possible mixture of electric quadrupole. A.

539.166.83

7706. *K*-conversion electron-gamma angular correlation measurements in Te^{121} and Te^{123}. N. GOLDBERG AND S. FRANKEL. Letter in *Phys. Rev.*, **93**, 1425 (*March* 15, 1954).

Measurements using a lens spectrometer for electron detection are reported. The results indicate that the ($M1$) γ-transitions contain $E2$ admixtures some 10^4 times greater than predicted on a single-particle model. J. J. WILKINS

539.166.83

7707. On the $L/(M + N)$ conversion ratio of the 80 keV gamma transition in ^{131}Xe. G. J. NIJGH, L. T. M. ORNSTEIN AND N. GROBBEN. Letter in *Physica*, **20**, 243–4 (*April*, 1954).

Measurements with a β-ray spectrometer are reported, giving the results $K/L = 6·8 \pm 0·4$ and $L/(M + N) = 4·8 \pm 0·8$. J. J. WILKINS

539.166.83

7708. Angular correlations between *K*-conversion electrons. E. BREITENBERGER. Letter in *Nature* [*London*] **173**, 737–8 (*April* 17, 1954).

A brief report of experiments on Br^{80} and Hg^{197} using extremely thin sources to minimize scattering and scintillation spectrometer detection to separate the conversion lines. A. O. STANESBY

539.166.83

7709. A precise momentum measurement of the *F* line of thorium B. D. I. MEYER AND F. H. SCHMIDT. *Phys. Rev.*, **94**, 927–30 (*May* 15, 1954).

The momentum of the internal-conversion electrons of the *F* line of thorium B has been compared with the momentum of electrons accelerated through a known potential difference. The comparison was made by means of an iron-free high-resolution solenoidal magnetic field β-ray spectrometer. The value obtained for the *F* line is $1388{\cdot}56 \pm 0{\cdot}21$ gauss-cm. Other useful calibration lines following the decay of thorium B have also been measured by comparison with the *F* line. A.

539.166.832

7710. Graphs of the Compton energy–angle relationship and the Klein–Nishina formula from 10 keV to 500 MeV. A. T. NELMS. *Circ. Nat. Bur. Stand., No.* 542, 89 *pp.* (1953).

These are presented graphically as functions of the energy and direction of the scattered photon and of the recoil electron. These graphs are intended to serve the purpose of tables. Unpolarized primary γ-rays in an energy range from 10 keV to 500 MeV are considered. The accuracy of all curves is estimated at 1%. The advantage of this form of presentation is the convenience and accuracy of two-way interpolation. In general, interpolated values may be obtained with an accuracy of 2%. A.

539.166.835

7711. Measurements on electron pairs, produced by γ-rays at an altitude of 4550 m (Monte Rosa). K. HINTERMANN. *Helv. phys. Acta*, **27**, *No.* 2, 125–43 (1954) *In German.*

Analysis of angles and energies of ~ 200 pairs in emulsions is consistent with Borsellino's theory (1953), but the plot of frequency of pairs against the fractional energy of the slower particle increases more rapidly than the Bethe–Heitler formula (1934). The energy and angular spectra of the incident photons are deduced. W. J. SWIATECKI

539.166.835

7712. Emission of electron–positron pairs from light nuclei. II. γ-transitions in ^{8}Be, ^{10}B and ^{16}O. S. DEVONS AND G. GOLDRING. *Proc. Phys. Soc.* [*London*] *A*, **67**, 413–20 (*May*, 1954).

For Pt I, see Abstr. 3823 (1954). The angular correlation of internally produced electron–positron pairs has been measured in the γ-transitions of several light nuclei. The measured correlation functions are compared with the theoretically predicted values and other information regarding the multipole character of the transitions. A.

539.166.835

7713. Magnetic quenching of the positronium decay. O. HALPERN. *Phys. Rev.*, **94**, 904–7 (*May* 15, 1954).

The influence of static and alternating magnetic fields on the radiative decay of positronium is investigated theoretically. Equations for the time variation of the probability amplitudes of the *ortho-* and *para-* states are presented and solved for various cases of experimental interest. In particular, formulae are derived which describe the resonance effects occurring in the case of a constant and a perpendicular alternating field. A.

539.166.835

7714. Annihilation of positrons in flight. J. B. GERHART, B. C. CARLSON AND R. SHERR. *Phys. Rev.*, **94**, 917–27 (*May* 15, 1954).

The weak continuous spectrum of hard γ-rays resulting from the stopping of positrons in various materials has been investigated with a NaI(Tl) scintillation spectrometer. Measurements were made chiefly in the γ-ray energy interval from 0·511 MeV to 1·3 MeV, for the continuous β-spectra of Ne^{19} and A^{35} (maximum positron energies of 2·2 MeV and 4·4 MeV, respectively). The experimental geometry was chosen to ensure averaging of the annihilation spectrum over all angles. Theoretical spectra were calculated for Lucite, brass, and lead as stopping materials. Comparison with experiment on an absolute basis was made possible by an experimental determination of the spectrometer efficiency as a function of γ-ray energy. The calculations included bremsstrahlung and single-quantum annihilation as well as two-quantum annihilation. In the case of Ne^{19} positrons annihilating in brass, the data are in satisfactory agreement with the calculations. However, the calculated spectra show a conspicuously stronger dependence on the atomic number of the stopping material than do the observed spectra. The experimental spectra from Ne^{19} positrons stopping in Lucite and brass are indistinguishable, while the calculated spectra show a brass to Lucite ratio of 1·3. In addition, the calculated intensities tend to be lower than the observed ones, particularly for A^{35} positrons and for stopping materials of low atomic number. A.

539.166.835

7715. The three-photon annihilation of positrons and electrons. S. DEBENEDETTI AND R. T. SIEGEL. *Phys. Rev.*, **94**, 955–9 (*May* 15, 1954).

The physical characteristics of the radiations emitted in the annihilation of positrons and electrons in the triplet state have been studied with a triple coincidence method. The energies of the three γ-rays, the angular distribution, and their polarization were found to agree with theory. Triplet annihilation was studied both from positrons stopping in gases where positronium was formed, and from positrons stopping in condensed materials. In the case of metallic absorbers, it was verified within the accuracy of the experiment that the number of triplet annihilations is 1/370 of the number of singlet events. Experiments on the number of three-quantum annihilations in different materials are described. A.

539.166.84

7716. Photon splitting in a nuclear electrostatic field. M. BOLSTERLI. *Phys. Rev.*, **94**, 367–8 (*April* 15, 1954).

The cross-section for the splitting of a photon into two photons in a nuclear electrostatic field has been

calculated from the vacuum polarization Hamiltonian of Euler and others to first order in $e^2/\hbar c$ for low energy incident photons ($p < mc$). For a favourable experimental case, photons of energy 840 keV incident on lead with antiparallel product photons each emitted at 90° relative to the incident photon, the cross-section is $2{\cdot}3 \times 10^{-33}$ cm^2/sterad^2. A.

539.167.3

7717. Hot atom chemistry. Photonuclear preparation of cobalt-58, cobalt-58m. D. C. HOFFMAN AND D. S. MARTIN, JR. *J. phys. Chem.*, **56**, 1097–101 (*Dec.*, 1952).

Samples of $K_3[Co(C_2O_4)_3].3H_2O$ were irradiated in the X-ray beam of the 68 MeV synchrotron. The Szilard–Chalmers process appeared to be nearly 100% effective in ejecting the radioactive cobalt atoms from the complex. The 9·2 hr Co^{58m} and 72 d Co^{58} formed during the irradiation were separated from the complex in high specific activity by adsorption on IRC-50 cation exchange resin. The total saturation yield for Co^{58} and Co^{58m} was found to be 8·6 relative to C^{11}. A solution of the complex was prepared from the active cobalt separated by adsorption on the resin. A method utilizing the chemical decomposition of the complex, occurring in the isomeric transition of Co^{58m} to Co^{58} by the emission of conversion electrons, was employed to calculate the ratio of the rates of formation of the two isomers. The ratio of the photonuclear rate of formation of Co^{58} to that of Co^{58m} was found to be $0{\cdot}61 \pm 0{\cdot}04$. A.

539.167.3

7718. Szilard–Chalmers reaction with cobalt phthalocyanine. A. NATH AND J. SHANKAR. Letter in *Curr. Sci.*, **22**, 372–3 (*Dec.*, 1953).

95·5% of the total activity produced when cobalt phthalocyanine is irradiated with thermal neutrons is found to be separable; the small retention is in harmony with the planar structure since this would offer little hindrance to the recoil Co atoms.

W. GOOD

539.167.3

7719. Separation of carrier-free S^{35} from NaCl irradiated with neutrons. M. CHEMLA AND P. SÜE. *C.R. Acad. Sci.* [*Paris*] **238**, 1502–4 (*April* 5, 1954) *In French.*

The method of separation of S^{35} from crystals of NaCl has been improved by using fine powders. The NaCl is melted, crushed, and irradiated with neutrons. S^{35} formed by the reaction ${}_{17}Cl^{35}(n, p){}_{16}S^{35}$ is extracted by heating to 720°C in a current of hydrogen; the yield is 95% in 30 minutes. Previously it was necessary to heat for 48 hours to get an 80% yield. The specimens obtained are free from P^{32} to nearly one part in 10 000 and contain less than 10^{-7} g of NaCl.

P. ROTHWELL

539.167.3

7720. Electromagnetic separation of spallation products. G. ANDERSSON. *Phil. Mag.*, **45**, 621–3 (*June*, 1954).

An electromagnetic isotope separator has been applied to the separation of radioactive spallation products of vanadium. The decay curves for the different mass numbers provided data for a determination of relative formation cross-sections. A fair agreement with earlier results, obtained with chemical methods was found. In some cases, where such methods have failed, complementary information was gained. The investigation also confirmed the mass assignments of K^{43} and K^{44}. A 34 min activity on mass number 45 could not be identified. A.

NUCLEAR REACTIONS 539.17

539.17 : 530.162

7721. The number of artificial nuclear reactions as a random variable. P. JAUHO. *Ann. Acad. Sci. Fennicae AI, No.* 165, 12 *pp.* (1954).

The probability of obtaining m induced radioactive reactions with n bombarding particles is calculated. The mean number of bombarding particles which must be used to cause m reactions is also calculated.

L. S. GODDARD

539.172

7722. Polarization of elastically scattered nucleons from nuclei. W. HECKROTTE AND J. V. LEPORE. Letter in *Phys. Rev.*, **94**, 500 (*April* 15, 1954).

Effects of a spin-orbit coupling potential are discussed qualitatively. G. E. BROWN

539.172

7723. Polarization from isolated resonances. A. SIMON AND T. A. WELTON. *Phys. Rev.*, **94**, 943–4 (*May* 15, 1954).

Polarization from nuclear reactions may be obtained even from a single isolated level of the compound nucleus. Some aspects of this type of polarization are discussed and the implications of the one-level Wigner–Eisenbud formula are considered in this connection. A conjecture of Coester is discussed and compared with the Wigner–Eisenbud result. A.

539.172

7724. Energy spectra of nucleons evaporated from a compound nucleus. R. M. EISBERG. Letter in *Phys. Rev.*, **94**, 739–40 (*May* 1, 1954).

The experimental data on the inelastic scattering of 30 MeV protons by Al is in definite disagreement with the evaporation model. These data, and also that from lower energy (p, p), (n, n) and (p, n) experiments can be explained on the basis of a direct interaction between the incoming particle and the nucleons forming the surface of the target nucleus.

P. T. MATTHEWS

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 7533–6, 7545

539.172

7725. $\pi^- - p$ interactions at 1·5 BeV. J. CRUSSARD, W. D. WALKER AND M. KOSHIBA. Letter in *Phys. Rev.*, **94**, 736–7 (*May* 1, 1954).

Analysis of 300 m of tracks in stripped emulsions exposed to a 1·5 BeV π^--beam gives a mean free path for $\pi^- - p$ interactions of 4 m. The events can be analysed into elastic and inelastic, and the angular

distributions of the resulting p's, π^-'s and π^0's are given. W. J. SWIATECKI

539.172

7726. Analysis of 405-MeV proton and 222-MeV negative pion stars. A. D. SPRAGUE, D. M. HASKIN, R. G. GLASSER AND M. SCHEIN. *Phys. Rev.*, **94**, 994–7 (*May* 15, 1954).

An analysis is carried out of star formation in emulsion by 405 MeV protons and 222 MeV negative pions produced in the University of Chicago 450 MeV synchrocyclotron. A comparison of the proton stars with a Monte Carlo calculation is made. The results indicate that the cascade mechanism is important in these stars, but that present evaporation theories cannot completely explain the decay of the residual nucleus. Pion and proton stars of almost the same total excitation have quite different characteristics. A.

539.172

7727. Nuclear interaction of fast μ mesons. M. ANNIS, H. C. WILKINS AND J. D. MILLER. *Phys. Rev.*, **94**, 1038–45 (*May* 15, 1954).

An experimental study has been made of events in which a fast μ-meson interacts with a nucleus to produce at least one evaporation neutron. The experimental results of major importance are $\sigma\bar{m} = (9{\cdot}1 \pm 1{\cdot}2)\times10^{-27}$ cm^2/Fe-nucleus; $1{\cdot}03 < \bar{m} < 7{\cdot}7 \pm 2{\cdot}2$; and $(1{\cdot}2 \pm 0{\cdot}4)\times10^{-27}$ cm^2/Fe-nucleus $< \sigma < (8{\cdot}8 \pm 1{\cdot}1)\times10^{-27}$ cm^2/Fe-nucleus, where σ is the cross-section for such events and $\bar{m}$ is the mean multiplicity of evaporation neutrons emitted. These results are in good agreement with the results of calculations based on present information on the nuclear interaction of γ-rays, which lead to the prediction of a σ of about $2{\cdot}4\times10^{-27}$ cm^2/Fe-nucleus and an $\bar{m}$ of about 3·3. The surprisingly large cross-section and small mean multiplicity of neutrons are shown to be reasonable by calculating that about 90% of all μ-meson nuclear interactions result in the transfer to the nucleus of less than 300 MeV. A.

539.172.13

7728. Energy spectrum of negative pions produced in beryllium by 2·3-BeV protons. Y. C. L. YUAN AND S. J. LINDENBAUM. Letter in *Phys. Rev.*, **93**, 1431 (*March* 15, 1954).

Using a counter telescope and analysing magnet the pion spectrum at $\theta_{lab} = 32°$ was measured from 180 to 870 MeV. Transformation to c.g. system shows a peak at 75–100 MeV suggesting production with mean multiplicity 2–3. W. J. SWIATECKI

539.172.13

7729. Nuclear reactions of copper with 2·2-BeV protons. G. FRIEDLANDER, J. M. MILLER, R. WOLFGANG, J. HUDIS AND E. BAKER. Letter in *Phys. Rev.*, **94**, 727–8 (*May* 1, 1954).

Cross-sections for the production of $\sim$ 50 radioactive nuclides have been measured. The estimated total inelastic cross-section is 0·8 b, in accord with physical studies of the interaction of 1·4 BeV neutrons. Direct ejection of light nuclei is indicated. J. M. CASSELS

539.172.13

7730. Gallium, germanium, and arsenic nuclides produced in the bombardment of copper with 2·2-BeV protons. A. TURKEVICH AND N. SUGARMAN. Letter in *Phys. Rev.*, **94**, 728 (*May* 1, 1954).

These nuclides were produced by secondary reactions, involving light nuclei ejected in the primary collisions of the protons with copper nuclei. J. M. CASSELS

539.172.13

7731. Angular distribution of deuterons from $N^{14}(p, d)N^{13}$. K. G. STANDING. Letter in *Phys. Rev.*, **94**, 731–2 (*May* 1, 1954).

This was measured for 18·7 MeV protons on melamine; deuterons were distinguished from protons by using a thin-crystal scintillation counter in coincidence with a thin proportional counter. The angular distribution indicates an angular momentum transfer $l_n = 1$, consistent with the assignment of $1+$ to the N^{14} ground state. A. O. STANESBY

539.172.13

7732. Comparison of nuclear and gamma-ray energy scales. K. W. JONES, R. A. DOUGLAS, M. T. MCELLISTREM AND H. T. RICHARDS. *Phys. Rev.*, **94**, 947–52 (*May* 15, 1954).

Cylindrical and spherical electrostatic analysers have been used to measure the ratio of the threshold proton energy for the $Li^7(p, n)Be^7$ reaction to the Q of the $Mg^{24}(p, p')\ Mg^{24*}$ reaction. This ratio was found to be $1{\cdot}3734 \pm 0{\cdot}0007$. The energy of the γ-ray from Mg^{24*} has been compared earlier by Hedgran and Lind to other γ-rays whose energies have been measured absolutely by either the curved crystal spectrometer method (Au^{198}, Caltech) or proton-moment calibrated magnetic field (Co^{60}, Lindstrom *et al.*). The present data fix the Li(p, n) threshold as $1881{\cdot}4 \pm 1{\cdot}1$ keV in terms of the Caltech value for the Au^{198} γ, or as $1879{\cdot}7 \pm 1{\cdot}1$ keV in terms of the Lindstrom *et al.* value for a Co^{60} γ-ray. The former value is in better agreement with currently used nuclear energy scales. A.

539.172.13

7733. Gamma rays from $N^{15}(p, \alpha\gamma)C^{12}$ and $N^{15}(p, \gamma)O^{16}$. A. A. KRAUS, JR. *Phys. Rev.*, **94**, 975–6 (*May* 15, 1954).

A new resonance in the reaction $N^{15}(p, \alpha\gamma)C^{12}$ giving the 4·43 MeV γ-ray from the first excited state of C^{12} has been found at a proton energy of $1{\cdot}64 \pm 0{\cdot}03$ MeV. The angular distribution of the γ-rays indicates that the resonant state in the compound nucleus O^{16} at an excitation energy of 13·65 MeV has spin and parity equal to 1^+ or 2^-. The resonance at 1·05 MeV proton energy has been reinvestigated. At this resonance the capture γ-rays from the reaction $N^{15}(p, \gamma)O^{16}$ are found to be isotropic, which indicates that this 13·09 MeV level of O^{16} has spin equal to 1. A search was made for capture γ-rays at the 0·340 MeV resonance of $N^{15}(p, \alpha)C^{12}$ but there were less than 1% of the number at the 1·05 MeV resonance. Therefore, it seems that these two levels do not have identical spin, parity and isotopic spin values. A.

539.172.13

7734. Spallation studies of bismuth. W. E. BENNETT. *Phys. Rev.*, **94**, 997–9 (*May* 15, 1954).

A study of the relative yields of polonium, bismuth, lead and thallium isotopes produced in the bombardment of bismuth with high-energy protons has been

carried out. It has been shown that the emission of neutrons is favoured over the emission of charged particles in the formation of spallation products in this region. A.

539.172.13

7735. Reactions of cesium with 240-MeV protons. R. W. Fink and E. O. Wiig. *Phys. Rev.*, **94**, 1357–61 (*June* 1, 1954).

Absolute yields of radionuclides produced in the spallation of caesium with 240 MeV protons have been measured from barium to ruthenium. The yields are based on the known cross-section for the monitor reaction $Al^{27}(p, 3pn)Na^{24}$. In agreement with the well-established pattern for high-energy spallation yields, the results indicate that the majority of reactions occur as primary knock-on collisions in which the incident proton interacts with only a few nucleons. This primary interaction is followed by a dissipation of the residual nuclear excitation, whose energy spread is very broad, leading to a distribution of products which reach far down the nuclide chart. Measurement of absolute X-ray counting efficiencies for the K X-rays of Xe^{131} and Mn^{55} in a methane β-proportional counter and in a helium-alcohol G.M. tube is also reported. A.

539.172.13 : 539.163.1

7736. The determination of the resonant energies for proton capture by ^{24}Mg and ^{25}Mg below 550 keV, and measurement of the half lives of ^{25}Al and ^{26}Al. S. E. Hunt, W. M. Jones, J. L. W. Churchill and D. A. Hancock. *Proc. Phys. Soc.* [*London*] *A*, **67**, 443–9 (*May*, 1954).

The energy of the proton beam from an air insulated Van de Graaff generator was measured absolutely by an electrostatic analyser, and the resonant energies for proton capture by Mg^{24} and Mg^{25} were determined by observing the positron yields. The following resonances were observed: $Mg^{24}(p, \gamma)Al^{25}$ $225{\cdot}5 \pm 0{\cdot}3$ and $418{\cdot}4 \pm 0{\cdot}4$ keV of half-widths $6{\cdot}0 \pm 1{\cdot}0$ and $2{\cdot}5 \pm 0{\cdot}5$ keV respectively. $Mg^{25}(p, \gamma)Al^{26}$ $316{\cdot}7 \pm 0{\cdot}7$, $391{\cdot}5 \pm 0{\cdot}5$, $495{\cdot}6 \pm 0{\cdot}6$, $513{\cdot}4 \pm 0{\cdot}7$ and $530{\cdot}4 \pm 0{\cdot}7$ keV, of half-widths $12{\cdot}0 \pm 1{\cdot}0$, $8{\cdot}0 \pm 1{\cdot}0$, $5{\cdot}0 \pm 1{\cdot}0$, $3{\cdot}0 \pm 1{\cdot}0$ and $3{\cdot}0 \pm 1{\cdot}0$ keV respectively. The half-lives of the positron decay of Al^{25} and Al^{26} were measured as $7{\cdot}62 \pm 0{\cdot}13$ and $6{\cdot}68 \pm 0{\cdot}11$ sec respectively. A.

539.172.13

7737. Variation of the angular distribution of $O^{16}(d, p)O^{17*}$ [875 keV level] protons near a deuteron capture resonance. A. Berthelot, R. Cohen, E. Cotton, H. Faraggi, T. Grjebine, A. Levêque, V. Naggiar, M. Roclawski-Conjeaud and D. Szteinsznaider. *C.R. Acad. Sci.* [*Paris*] **238**, 1312–14 (*March* 22, 1954) *In French.*

Angular distributions were measured at seven deuteron energies between 1·66 and 2·20 MeV. Forward maxima, consistent with a stripping reaction ($l_N = 0$), were obtained at all energies. For angles $>30°$, the distributions varied considerably with energy. J. J. Wilkins

539.172.13

7738. The production of 320-MeV deuterons by He^3 stripping. J. Ise, Jr, R. V. Pyle, D. A. Hicks and R. M. Main. *Rev. sci. Instrum.*, **25**, 437–42 (*May*, 1954).

Deuterons can be accelerated in the 184 in. cyclotron to 190 MeV. To produce higher-energy deuterons, doubly charged He^3 ions are accelerated to 493 MeV, and a fraction of them are stripped in an internal target, yielding deuterons with an average energy of 330 MeV. A current of 5×10^{-13} A is obtained in the experimental "cave" external to the cyclotron shielding. Range measurements indicate that these deuterons have an average energy of about 320 MeV. The high cost of He^3 necessitates an efficient gas-recovery system. The exhaust from the cyclotron diffusion pump is passed through activated charcoal traps which are cooled to liquid-nitrogen temperatures, and the gas that is not adsorbed (presumably helium) is returned to the cyclotron source. The loss from all causes is $0{\cdot}8$ cm^3/hr. A.

539.172.3

7739. Study of photodisintegrations using photographic emulsions: photodisintegration of carbon into three α-particles. II. R. Chastel. *J. Phys. Radium*, **15**, 240–50 (*April*, 1954) *In French.*

For Pt I, see Abstr. 3854 (1954). An experiment using $Li(p, \gamma)$ radiation is described in detail. Possible mechanisms of the $C^{12}(\gamma, 3\alpha)$ reaction, viz. "tripartition" or disintegration via Be^8, are discussed.

J. J. Wilkins

539.172.3

7740. Angular anistropy of specific thorium photofission fragments. A. W. Fairhall, I. Halpern and E. J. Winhold. Letter in *Phys. Rev.*, **94**, 733–4 (*May* 1, 1954).

Anisotropy in the angular distribution of photofission fragments from thorium has previously been observed by counting the total β-activity of the fragments caught at various angles with respect to the X-ray beam. The 16 MeV thick target bremsstrahlung from the M.I.T. linear accelerator was used to compare the number of fragments emitted per unit solid angle at 90° to the X-ray beam with the average of the numbers at 0° and 180° for 7 specific fission-product elements: Br, Ag, Sb, Te, I, Ba, Ce. The angular distribution in each case has the form $a + b \sin^2 \theta$, and the values of b/a are plotted as a function of the mass ratio of the heavy to light fission fragment pair. Over the range measured b/a increases monotonically as a function of this mass ratio.

D. R. Chick

539.172.3

7741. High-energy photoproton production by 325-MeV bremsstrahlung radiation. B. T. Feld, R. D. Godbole, A. Odian, F. Scherb, P. C. Stein and A. Wattenberg. *Phys. Rev.*, **94**, 1000–10 (*May* 15, 1954).

Photoprotons with energies above 120 MeV have been studied at the M.I.T. synchrotron. Angular distributions of protons with 126 MeV, 169 MeV and 203 MeV were obtained in the angular range from 20° to 160° from both beryllium and carbon targets. These observations showed that the protons in a Be and in a C nucleus behave identically in high energy photoproton production. The energy distribution of photoprotons from carbon at 30° was investigated in

particular detail. A break is observed in the energy distribution which appears to be in accordance with Levinger's "quasi-deuteron model." Absolute values for the differential and total cross-sections were obtained. A detailed analysis of existing data is given which raises the possibility that the agreement with the "quasi-deuteron model" may be fortuitous. A.

539.172.3

7742. Cross section for the reaction $Al^{27}(\gamma, n)Al^{26}$. R. N. H. Haslam, W. N. Roberts and D. S. Robb. *Canad. J. Phys.*, **32**, 361–4 (*June*, 1954).

The cross-section for the reaction $Al^{27}(\gamma, n)Al^{26}$ has been remeasured by the determination of Al^{26} activity. The results are in agreement with an earlier value obtained by the activity method, but differ from the result obtained by neutron detection. The discrepancy is thought to be due to complexity in the Al^{26} decay scheme. The reaction threshold is measused as $13{\cdot}4 \pm 0{\cdot}2$ MeV, the maximum energy of positrons from Al^{26} is $3{\cdot}2 \pm 0{\cdot}1$ MeV, and the half-life is determined as $6{\cdot}5 \pm 0{\cdot}1$ sec. A.

539.172.4

7743. Small-angle neutron-proton scattering at 90 MeV. O. Chamberlain and J. W. Easley. Letter in *Phys. Rev.*, **94**, 208 (*April* 1, 1954).

A neutron beam (obtained by stripping 190 MeV deuterons on a Be target) was scattered from a 5·6 in. dia. cylinder of liquid hydrogen. The scattered neutrons produced proton recoils or nuclear interactions within a polyethylene convertor, and these were detected by a scintillation counter telescope. The thickness and shape of an absorber used after the convertor was adjusted, at each scattering angle, to ensure that the scattered neutron from the target should have an energy greater than $60 \cos^2 \Theta$ MeV in the range of laboratory scattering angles $2{\cdot}5° < \Theta < 18{\cdot}5°$, and that this minimum neutron energy should be independent of the angle at which the protons recoiled from the convertor. The results appear to indicate a marked similarity of the differential cross-section in the region of 0° to that in the region 180°. D. R. Chick

539.172.4

7744. Measurement of the neutron-proton cross section at 1·0 and 2·5 MeV. R. E. Fields, R. L. Becker and R. K. Adair. *Phys. Rev.*, **94**, 389–98 (*April* 15, 1954).

The total cross-section of hydrogen for 1·0 and 2·5 MeV neutrons has been determined by measuring the neutron transmission of samples of 2–2–4 trimethylpentane and graphite. Electrostatically analysed protons from an electrostatic generator were used to bombard thin targets of tritium absorbed in zirconium to produce 2·5 MeV neutrons, and thin targets of Li_2O to produce 1·0 MeV neutrons. A gas-filled recoil counter served as neutron detector. For both cross-section determinations the geometry of the measurement was such that neutrons scattered from the samples at angles greater than 4·2° in the laboratory system were not detected. A pulse-height discriminator, biased to reject pulses from low-energy neutrons, reduced the background from room-scattered neutrons to less than 1% and eliminated effects of low-energy neutron groups from the $Li^7(p, n)$ reaction and the $O^{18}(p, n)$ reaction. Neutron energy spreads, primarily caused by the finite target thicknesses, were determined by measuring the widths of narrow neutron-scattering resonances in sulphur and carbon. The results of the cross-section measurements are: $\sigma = 2{\cdot}525 \pm 0{\cdot}009 \times 10^{-24}$ cm^2 at a neutron energy of 2·540 MeV, and $\sigma = 4{\cdot}228 \pm 0{\cdot}018 \times 10^{-24}$ cm^2 at a neutron energy of 1·005 MeV. These values, together with the values of a_t, a_s and ρ_t given by Burgy, Ringo and Hughes yield values of the singlet effective range in the shape independent approximation of $2{\cdot}48 \pm 0{\cdot}20 \times 10^{-13}$ cm from the 2·5 MeV measurement, and $2{\cdot}56 \pm 0{\cdot}25 \times 10^{-13}$ cm from the 1·0 MeV observations. These effective ranges are consistent with the proton-proton scattering data and the hypothesis of the charge independence of nuclear forces. A.

539.172.4

7745. The pickup reactions $B^{10}(n, d)Be^9$ for 14-MeV neutrons. F. L. Ribe and J. D. Seagrave. *Phys. Rev.*, **94**, 934–40 (*May* 15, 1954).

Measurements have been made of the yields and angular distributions of deuterons resulting from the bombardment of B^{10} by 14 MeV neutrons. The spectrum of charged reaction products was measured by means of a coincidence-telescope spectrometer consisting of two proportional counters and a thin NaI scintillator. The telescope was rotated to obtain measurements at various angles. Deuterons corresponding to the ground state and 2·43 MeV excited state of Be^9 were identified by measurements of both their energy and dE/dx values. The ground-state angular distribution was found to match the expected Butler inverse-stripping curve for $l_p = 1$. The Butler analysis for the excited-state deuterons also gave $l_p = 1$, corresponding to odd parity and spin 3/2, 5/2, 7/2 or 9/2 for the first excited state of Be^9. In particular, the spin value 1/2, to be expected from the L–S coupling model, is excluded. The cross-sections, integrated from zero to 90° (centre-of-mass), are 21 ± 3 and 16 ± 2 millibarns, respectively, for the ground- and excited-state reactions. A.

539.172.4

7746. Curium isotopes 246 and 247 from pile-irradiated plutonium. C. M. Stevens, M. H. Studier, P. R. Fields, J. F. Mech, P. A. Sellers, A. M. Friedman, H. Diamond and J. R. Huizenga. *Phys. Rev.*, **94**, 974 (*May* 15, 1954).

Mass spectrometric analyses show the presence of curium 246 and curium 247 in curium samples produced from neutron-irradiated plutonium. The pile-neutron capture cross-sections of Am^{243}, Cm^{244}, Cm^{245}, Cm^{246} are 115 ± 20, 25 ± 10, 200 ± 100 and 15 ± 10 barns, respectively. The α-disintegration half-life of Cm^{244} is calculated to be $19{\cdot}2 \pm 0{\cdot}6$ years. A.

539.172.4

7747. Neutron capture in the separated isotopes of platinum. J. M. Cork, M. K. Brice, L. C. Schmid, G. D. Hickman and H. Nine. *Phys. Rev.*, **94**, 1218–21 (*June* 1, 1954).

Using the separated isotopes of platinum, irradiated in the pile, the energies of the γ-rays for the activities of Pt^{191}, Pt^{193} and Pt^{195} have been evaluated. For Pt^{191} fifteen γ-rays are found which fit well a simple

level scheme. Pt^{193} emits isomerically a γ-ray followed by K capture to iridium, with the possible emission of a high-energy γ. Pt^{195} emits a highly converted γ-ray followed by two others in rapid succession decaying to the stable isotope. The half-lives of the three activities are found to be 2·90, 3·35 and 6 days, respectively. A.

539.172.4

7748. Interaction of polarized neutrons with polarized Mn^{55} nuclei. S. Bernstein, L. D. Roberts, C. P. Stanford, J. W. T. Dabbs and T. E. Stephenson. *Phys. Rev.*, **94**, 1243–51 (*June* 1, 1954).

The dependence of the capture cross-section of polarized Mn^{55} nuclei for polarized neutrons upon relative orientations of incident and bombarded particles has been directly observed. The target material was the paramagnetic substance, manganous ammonium sulphate, which is known to have a large hyperfine structure coupling. It was placed in a magnetic field of 2350 oersteds at a temperature of 0·20°K. Under these conditions the polarization of the paramagnetic electrons is about 85%. Because of the large effective magnetic field created by the paramagnetic electrons at the Mn nucleus, the nuclei should achieve a polarization of 16%. The 2·6 hour activity of the residual nucleus, Mn^{56}, was measured after the sample had been bombarded with a beam of slow neutrons polarized to the extent of 32% by passage through magnetized iron. The activity for neutron polarizing field and sample polarizing field parallel was found to be 3·4% less than for the fields antiparallel. The difference in the two activities was found to depend upon the sample temperature in accordance with theory. The difference was found to be unaccompanied by a corresponding change in sample transmission. These results are interpreted to mean that the change in sample activity was due to the dependence of the capture cross-section of the polarized Mn nuclei upon the relative orientation of the interacting particles. The observations are discussed in terms of available information about the energy level system of the compound nucleus, Mn^{56}. A.

539.172.4

7749. Angular distribution of neutrons scattered from cadmium, tin, and bismuth. S. C. Snowdon and W. D. Whitehead. *Phys. Rev.*, **94**, 1267–72 (*June* 1, 1954).

The differential cross-sections for the scattering of 3·7 MeV neutrons from cadmium, tin and bismuth have been measured over an angular range between 13° and 140° with an angular resolution of about ±10°. The effects due to higher-order scattering have been removed at each measured angle by extrapolation. Previous measurements of the differential cross-sections of aluminium, iron and lead gave a uniform shift of the position of the first minima in the curve with atomic weight. In the present measurements, the curves for cadmium and tin, while quite similar, do not fall uniformly between those of iron and lead. The curve for bismuth, however, is again quite similar to that for lead. Possible explanations of this behaviour are discussed in light of the continuum theory of nuclear reactions. A.

539.172.4

7750. Thermal neutron fission cross section of Am^{242m}. G. H. Higgins and W. W. T. Crane. Letter in *Phys. Rev.*, **94**, 735 (*May* 1, 1954).

The value obtained by comparison with U^{235} was 2950 barns [no error given]. A. O. Stanesby

539.172.4

7751. Yields of fission products from U^{238} irradiated with fission spectrum neutrons. R. N. Keller, E. P. Steinberg and L. E. Glendenin. *Phys. Rev.*, **94**, 969–73 (*May* 15, 1954).

A radiochemical investigation of the fission yields of 15 products in the fission of U^{238} is described. The average energy of the neutrons effective in inducing fission is estimated as 2·8 MeV. The familiar twin-peaked yield-mass distribution is observed with a peak-to-trough ratio of 200 to 1. A comparison of the fission yield-mass curve for U^{238} with those for other fissile nuclei is made. A.

539.172.4

7752. Some studies of the products of the high-energy fission process. M. Lindner and R. N. Osborne. *Phys. Rev.*, **94**, 1323–8 (*June* 1, 1954).

The energy dependence of the formation cross-section of certain nuclides formed in fission of uranium and thorium has been studied. Excitation functions in the hundred MeV region are given for Ni^{66}, Zr^{97}, Ag^{111}, Ba^{131} and Ba^{139}. Protons, deuterons and α-particles from the Berkeley 184 in. frequency-modulated synchrocyclotron were used to induce the activities. It was found that the yields of neutron-deficient fission products increase with energy; those with an excess of neutrons decrease in yield. Helium ions impart greater nuclear excitation than do protons of the same energy. Neutron-deficient fission products have nearly identical cross-sections for formation in uranium and thorium; those with an excess of neutrons are formed in higher yield in uranium. The results indicate that some of the fissioning events may be preceded by the evaporation of about twenty-five nucleons. A.

539.172.4

7753. Kinetics of the circulating-fuel nuclear reactor. W. K. Ergen. *J. appl. Phys.*, **25**, 702–11 (*June*, 1954).

In a circulating-fuel reactor, the circulation of the fuel causes a damping of power oscillations of the reactor. This is demonstrated under the assumption that there is no mechanical vibration coupled with the oscillation of reactor power, and that the shape of the hydrodynamic flow does not vary with time. A.

539.174

7754. Coulomb excitation by means of bombardment with various particles. J. H. Bjerregaard and T. Huus. Letter in *Phys. Rev.*, **94**, 204 (*April* 1, 1954).

The multipole character of the field giving rise to Coulomb excitation of a nuclear level may be found from relative cross-section measurements using different bombarding particles. The $E2$ excitation of the 100 keV level in W^{182} was confirmed using protons, deuterons and α-particles. M. A. Grace

539.174

7755. Emission of δ- and X-rays from targets bombarded by accelerated ions. Č. Zupančič and T. Huus. Letter in *Phys. Rev.*, **94**, 205 (*April* 1, 1954).

The background of X-rays, bremsstrahlung and

δ-rays occurring during the Coulomb excitation of nuclei has been measured and its theoretical interpretation is discussed. M. A. GRACE

539.174 : 539.152.1

Coulomb excitation of Ta and W by 2 MeV protons. *See Abstr.* 7648–50

ATOM AND MOLECULE BEAMS . MESONS. NEUTRONS 539.18

539.18

7756. On the capture of μ^- mesons by light nuclei. A. ALBERIGI-QUARANTA AND E. PANCINI. *Nuovo Cimento*, **11**, 607–17 (*June*, 1954) *In Italian.*

An experiment is described to test the validity of Wheeler's law for the Z-dependence of the probability of capture of negative μ-mesons by light nuclei ($Z \leqslant 26$). With an apparatus previously described [Abstr. 7949 (1953)] the apparent mean life of the μ-mesons τ^- has been measured in Al and S, with the result $\tau^- = 1{\cdot}02 \pm 0{\cdot}04$ in Al and $\tau^- = 0{\cdot}70 \pm 0{\cdot}04$ in S. Using these values, those obtained previously for C, and a value obtained by Keuffel *et al.* for Fe, it is concluded that Wheeler's theory is sufficient to explain, within the limits of accuracy at present attainable, the dependence on Z of the capture probability p_c in light nuclei ($Z \leqslant 26$). The values $k = 4{\cdot}4 \pm 0{\cdot}3$ and $Z_0 = 11{\cdot}3$ are found for the constants introduced by Wheeler in the law $p_c = (1/\tau_0)(Z_e/Z_0)^k$. A.

539.18

7757. μ-meson decay spectrum. J. H. VILAIN AND R. W. WILLIAMS. *Phys. Rev.*, **94**, 1011–17 (*May* 15, 1954).

The energy spectrum of positrons from the decay of muons at rest has been measured, using a synchrotron as the meson source and a magnetic-field cloud chamber as the spectrometer. A total of 830 tracks was obtained, and the relation between this sample and the true decay spectrum is discussed in some detail; difficulties which may have led to the discrepancies among previously-measured spectra are pointed out. A strict set of selection criteria reduced the sample to 280 tracks; from this it is found that the spectral intensity does not go to zero at the upper energy limit, but retains a large value. In terms of Michel's parameter, $\rho = 0{\cdot}50 \pm 0{\cdot}13$. A.

539.18

7758. Decay of τ mesons of known charge. R. H. DALITZ. *Phys. Rev.*, **94**, 1046–51 (*May* 15, 1954).

The experimental data on the 3π decay of τ-mesons is summarized on a convenient two-dimensional plot, both (*a*) when the π-meson charges are known, and (*b*) when they are not. Some events may be included in plot (*a*) only if the parent τ-meson is assumed positive and arguments supporting this identification for τ-mesons decaying in an emulsion are discussed. The dependence of this plot on the τ-meson spin (j) and parity (w) is discussed in general terms and those features depending particularly on w and on its relation with j are emphasized—for example, if the density of events does not vanish at the bottom of the plot, the τ-meson must have odd parity and even spin. Simple estimates of the distribution, using only the lowest allowable angular momenta and a "short range" approximation, may be modified by final-state meson-meson attractions, whose effects are discussed qualitatively. The available data are insufficient for any strong conclusion to be drawn but rather suggest even spin and odd parity for the τ-meson; the need for careful assessment of geometrical bias in the selection of experimental material is stressed. A.

539.18

7759. The classification and mean lifetime of θ^0- and Λ^0-particles. D. B. GAYTHER. *Phil. Mag.*, **45**, 570–82 (*June*, 1954).

A study is made of the properties of the decays of about 50 V^0-particles in a medium-sized cloud chamber equipped with either one or two lead plates but without a magnetic field. The decays are classified into those due to θ^0- and to Λ^0-particles using methods suggested by Podolanski and Armenteros [Abstr. 1747 (1954)]. The mean lives of the θ^0- and Λ^0-particles are found to be $(1{\cdot}2^{+0{\cdot}8}_{-1{\cdot}3}) \times 10^{-10}$ sec and $(4{\cdot}0^{+3{\cdot}7}_{-1{\cdot}2}) \times 10^{-10}$ sec respectively. A.

539.18

7760. *K*-meson and hyperon decays. P. H. BARRETT. *Phys. Rev.*, **94**, 1328–30 (*June* 1, 1954).

A stack of 400 μ Ilford G-5 nuclear emulsion surrounded by 5·5 cm of brass was flown at 85 000 feet for 10 hours at $\lambda = 41°$N. While scanning 409 cm² of these emulsions the decay of seven K-particles and one τ-meson have been observed. A hyperon produced in a star is seen to decay into an L-meson. For the decay scheme $Y^{\pm} \rightarrow \pi^{\pm} + n + Q$ this event gives $Q = (48 \pm 20)$ MeV. A heavy nuclear fragment ($Z \sim 5$) from an eight-prong star decays into Li^8, a proton, and a particle that is probably a deuteron. An event has been observed that could be interpreted as an example of the decay of a τ-meson by the decay scheme $\tau^+ \rightarrow \pi^+ + 2\,\pi^0$. A.

539.18

7761. *V* particles and the gamma decay of a neutral pion. T. KINOSHITA. *Phys. Rev.*, **94**, 1384–5 (*June* 1, 1954).

It is shown that the previous theoretical calculations of the lifetime for the γ-decay of the π^0-meson must be subject to an obvious modification because of the presence of new particles recently discovered experimentally. This may be regarded as an example of the fact that, in some cases, the meson-nucleon system cannot be treated as being insolated from the rest of the elementary particles. An accurate numerical prediction for the lifetime cannot be given until sufficient knowledge about the new particles is accumulated. Some features of Pais' theory of the V-particles are discussed in connection with this problem. A.

539.18

7762. On the mass of the Λ^0-particle. M. W. FRIEDLANDER, D. KEEFE, M. G. K. MENON AND M. MERLIN. *Phil. Mag.*, **45**, 533–42 (*May*, 1954).

In a stack of stripped photographic emulsions, 20 events of type $2 + 0_n$ have been observed, in each of which the outgoing particles are a proton and a

negative π-meson respectively; the latter particle was identified by the characteristic star it produced when brought to rest in the emulsion. Assuming that each of these events represents the decay in flight of a neutral hyperon according to the scheme $\Lambda^0 \rightarrow \pi^- + p + Q$, values of the energy release Q have been calculated. In eleven of the events the proton could be traced to the end of its range; the energies of both particles could then be deduced using appropriate range–energy relations. In the remaining nine examples, the energy of the proton was deduced from grain-density considerations and was accordingly less well determined. Ten cases yield Q-values in the interval 35·5–38·5 MeV. These have been interpreted as examples of the decay of a Λ^0-particle with a unique Q of ~37 MeV. The weighted mean Q-value obtained for the ten examples is then $36{\cdot}92 \pm 0{\cdot}22$ MeV. It is not yet possible to decide whether there are neutral hyperons with a similar decay scheme but with a different release of energy. It is clear from these and other measurements, that results of high precision can be obtained with the use of stripped emulsions. At the present stage in their use, however, there is one possibly serious source of error, namely, uncertainties in the stopping power of the emulsions. This and other errors are discussed in detail and their effects evaluated in obtaining the final results. The mass of the Λ^0-particle as deduced from these experiments is $2181 \pm 1\ m_e$. A.

539.18

7763. Kinematics of Λ^0 production. G. T. Reynolds and S. B. Treiman. Letter in *Phys. Rev.*, **94**, 207–8 (*April* 1, 1954).

From the kinematics of $n + n' \rightarrow n + \Lambda^0$, $\pi + n' \rightarrow \pi + \Lambda^0$, $\pi + n' \rightarrow k_1 + \Lambda^0$, $\pi + n' \rightarrow k_2 + \Lambda^0$ processes, where n' is a neutron in a 20 MeV Fermi gas, the percentage probability for a Λ^0 with less than 70 MeV is plotted against incident energy. To obtain the observed $> \sim 10\%$ [Abstr. 786 (1954)] a strongly anisotropic Λ^0 production must be assumed, e.g. $n > 6$ in $\cos^n \theta$ (c.m. system). W. J. SWIATECKI

539.18

7764. Effect of deuteron formation on multiple meson production. K. A. Brueckner and J. S. Kovacs. Letter in *Phys. Rev.*, **94**, 726–7 (*May* 1, 1954).

The statistical theory of meson production must be modified to take into account the effect of interactions in final states. The ratio of the volumes in phase space associated with $n\pi + D$ and $n\pi + N + P$ productions are plotted against energy: they become very large ($> \sim 30$) near threshold, especially for large n.

W. J. SWIATECKI

539.18

7765. Photoproduction of π^+ mesons from hydrogen near threshold. G. Bernardini and E. L. Goldwasser. Letter in *Phys. Rev.*, **94**, 729 (*May* 1, 1954).

An experiment using a liquid hydrogen target and nuclear emulsion detectors is described. Yields were obtained for 175, 185 and 195 MeV γ-ray energies and for (laboratory) angles between 30° and 150°. The results are consistent with predominant s-wave emission of the mesons. J. J. WILKINS

539.18

7766. Effect of Coulomb barrier on meson production by nucleon–nucleus collisions. T. Kinoshita. *Phys. Rev.*, **94**, 1331–4 (*June* 1, 1954).

The effect of the Coulomb barrier on charged meson production by nucleon–nucleus collisions is studied by a classical and qualitative treatment of the Coulomb interaction between the emitted meson and the residual nucleus. Especially, the discrepancy in the behaviour of positive and negative meson production cross-sections as functions of atomic number can be understood qualitatively by this simple argument. A.

539.18

7767. On the inelastic scattering of π-mesons by complex nuclei. F. Lévy. *C.R. Acad. Sci.* [*Paris*] **238**, 1412–14 (*March* 29, 1954) *In French.*

The interaction of a meson with nucleons described by a Fermi gas (individual collision characteristics taken from π–p experiments) leads to inelastic cross-sections showing the observed preponderance of 180° over 90° scattering, but predicting a most probable energy loss of ~ 20 MeV instead of some 70% of the incident energy of 75 MeV. W. J. SWIATECKI

539.18

7768. Classical scattering of mesons. S. P. Pandya. *Phys. Rev.*, **94**, 1037–8 (*May* 15, 1954).

The theory of "action at a distance" proposed by Wheeler and Feynman for electrodynamics has been extended by various authors to meson fields. It is shown here that the cross-sections for the scattering of mesons by nucleons in various cases (charge, dipole, or isotopic spin scattering for scalar or vector mesons) obtained in this theory differ from those obtained in the classical field theory by the absence of those terms which have been interpreted as modification of the nucleon parameter involved in the scattering, due to the reaction of the meson field on the nucleon. A.

539.18

7769. Scattering of 217-MeV negative pions by hydrogen. M. Glicksman. *Phys. Rev.*, **94**, 1335–44 (*June* 1, 1954).

The differential cross-sections for scattering of 217 MeV negative pi mesons by liquid hydrogen have been observed at six angles. An analysis of the angular distribution of the ordinary scattering is consistent with a small d-wave contribution; the charge-exchange scattering angular distribution agrees with the assumption of only s and p waves. The integrated total cross-sections are $18{\cdot}2 \pm 2{\cdot}3 \times 10^{-27}$ cm^2 for the ordinary scattering and $35{\cdot}8 \pm 3{\cdot}4 \times 10^{-27}$ cm^2 for the charge exchange scattering. Transmission measurements of the total cross-section gave values of $57{\cdot}2 \pm 2{\cdot}9 \times 10^{-27}$ cm^2 at 209 MeV and $52{\cdot}1 \pm 2{\cdot}3 \times 10^{-27}$ cm^2 at 220 MeV. An analysis of the angular distributions in terms of phase shifts is discussed. A.

539.18

7770. Strange particles and multiple meson production. G. Cocconi. Letter in *Phys. Rev.*, **94**, 741–2 (*May* 1, 1954).

Qualitative arguments are given that heavy mesons are compounds of nucleons and π-mesons.

P. T. MATTHEWS

539.185

7771. On the free path of neutrinos. F. G. Houtermans and W. Thirring. *Helv. phys. Acta*, **27**, *No.* 2, 81–8 (1954) *In German.*

Discussion of lower limits obtained experimentally ($10^9 - 10^{11}$ g/cm^2) and theoretical estimates for inverse β-decay (10^{18} g/cm^2), scattering on electrons (10^{23}), ionization due to magnetic moment (10^{20}).

W. J. SWIATECKI

539.185

7772. The design of cold neutron filters. P. A. Egelstaff and R. S. Pease. *J. sci. Instrum.*, **31**, 207–12 (*June*, 1954).

The problems of designing cold neutron filters are surveyed and discussed. Theoretical expressions for the mean wavelengths and fluxes of the cold neutron beams are given. The choice of filter material is discussed and the physical state of the material is shown to be an important factor. Filters using beryllium, magnesium, magnesium oxide, lead and bismuth have been made and their performances tested and compared with theory. A.

539.185

7773. Doppler effect in the slow neutron resonance in rhodium. H. H. Landon. *Phys. Rev.*, **94**, 1215–17 (*June* 1, 1954).

The variation in transmission of a rhodium foil to 1·26 eV neutrons has been measured as a function of foil temperature using a crystal spectrometer. A change in transmission of approximately 2% per 100-degree temperature change has been observed over a temperature range from 120°K to 860°K. After correction for instrument resolution and Doppler effect, a peak cross-section of 4850 ± 200 barn results. Comparison has been made with the theory of Bethe and Placzek as extended by Lamb. A.

539.185

7774. A nuclear method for the estimation of traces of light water in heavy water. G. L. Squires. *Proc. Phys. Soc.* [*London*] *A*, **67**, 520–4 (*June*, 1954).

The transmission of slow neutrons through a sample of the water is compared with that through a standard sample. The method gives an accuracy to 0·006% in the heavy water content after 3 hours' counting. A.

539.185

7775. A study of the interaction of neutrons with moderating materials. G. F. von Dardel. *Phys. Rev.*, **94**, 1272–83 (*June* 1, 1954).

The time-dependence of the slowing-down process is considered for certain simple cases: (1) For free nuclei at rest an approximate expression is found for the velocity distribution. (2) The existence of a bond in one direction while the motion is unhindered in other directions is found to have little influence on the slowing-down process. (3) The slowing-down process in a monatomic gas is discussed quantitatively on the assumption of a Maxwellian neutron velocity distribution. The experimental part of the paper reports measurements with a pulsed neutron source and a time analyser, in which the variations of the neutron velocity spectrum with time were studied by transmission measurements. Measurements on water show that the neutrons approach thermal equilibrium with the moderator at a rate which is in agreement with the theoretical predictions. The equilibrium temperature of the neutrons is found to agree with the moderator temperature over a wide temperature range. At low temperatures evidence is found for the effect of the lattice forces on the slowing-down process. Measurements on the initial slowing-down process for neutrons in heavy water indicate satisfactory agreement with the theory for slowing down by free deuterons at rest. The various factors which determine the rate of decay of the neutron intensity in a moderator are discussed, and the feasibility of using measurements of the decay rate to determine the diffusion and absorption properties of the moderating material as well as the geometrical buckling of complicated moderating systems is considered. In an appendix tables are given for the absorption of thermal neutrons in $1/v$ absorbers. A.

539.185

7776. Neutron polarization. C. P. Stanford, T. E. Stephenson, L. W. Cochran and S. Bernstein. *Phys. Rev.*, **94**, 374–81 (*April* 15, 1954).

The neutron polarization cross-section of iron has been measured as a function of energy from 0·7 to 3·3 Å by two methods: using the single transmission effect in a block of polycrystalline iron at energies selected by a quartz crystal monochromator; and using a single crystal of magnetized magnetite to analyse the beam emerging from the iron polarizer, the magnetite crystal itself serving as monochromator. The measured values are compared with those of other observers and the theoretically expected values. These are found to agree fairly well within the limits of accuracy of the measurements and existing knowledge of the wave function of the iron 3*d* shell. The two techniques were used also to determine the average polarization (32%) as seen by a $1/v$ detector in a beam of reactor neutrons emerging from a 4 cm thick polarizing block of iron. Problems and techniques associated with the measurement of the average polarization of a continuous spectrum are discussed. A simplified experimental treatment of the problem of beam "hardening" is described. A description is given of the use of the magnetic resonance method in conjunction with a single-crystal magnetite analyser for the measurement of neutron polarization. A.

539.185

7777. Neutron optics. D. J. Hughes. *New York: Interscience Publishers* (1954) 136 *pp.*

Review in *Phil. Mag.*, **45**, 661 (*June*, 1954). ". . . the first of a series of tracts published 'to provide non-specialists with authoritative and relatively brief and inexpensive accounts of recent advances in the many specialized branches of physics and astronomy.'"

539.185

7778. The scattering of neutrons by systems containing light nuclei. G. C. Wick. *Phys. Rev.*, **94**, 1228–42 (*June* 1, 1954).

The general expression for the slow-neutron cross-section of a molecule is cast in a form which allows an explicit formulation of the assumption, that the

duration of the collision is short compared to the natural periods of the molecule. It is shown that the assumption allows one to extend Placzek's results to molecules containing light nuclei, with only minor modifications. The limits of validity of the assumption are discussed, and the possibilities of exceptions are studied in detail on some examples. A.

539.185.08 : 621.384.62

7779. The development of a neutron spectrometer for the intermediate energies. F. S. Goulding, J. C. Hammerton, M. G. Kelliher, A. W. Merrison and E. R. Wiblin. *Proc. Instn Elect. Engrs II*, **101**, 248–59 (*June*, 1954).

For abstract, see Abstr. 7192 (1953).

539.185.9 : 535.371

Effect of neutron bombardment on a zinc sulphide phosphor. *See Abstr.* 7323

STRUCTURE OF SOLIDS 539.2

539.216

7780. Continuous versus discontinuous beaters. G. Bozza and P. Ghisoni. *Nuovo Cimento Suppl.*, **11**, *No.* 1, 1–16 (1954).

This is a theoretical study of beaters used in the manufacture of paper from pulp, in relation to the strength of the finished product.

539.216

7781. The distribution of bismuth in copper during solidification. K. Toman and V. Petržílka. Letter in *Czech. J. Phys.*, **4**, 94 (*Feb.*, 1954) *In Russian.*

Radioactive Bi^{210} (RaE), was introduced into molten copper. A surface was machined on the solidified metal, finished with a diamond tool and etched autoradiographs were taken from the surface. The radioactivity was found to reside in the eutectic material lying between dendritic growths of pure copper. The initial concentration of Bi was 0·2%.

A. L. MACKAY

539.217

7782. Diffusion of labelled disodium phosphate in a chemically homogeneous medium. J. Salvinien, R. Marignan and S. Cordier. *C.R. Acad. Sci.* [*Paris*] **238**, 888–90 (*Feb.* 22, 1954) *In French.*

Cofficients of diffusion have been determined for Na_2HPO_4 (labelled with P^{32}), over a concentration range 0·025–0·5M, in a 10% gelatin gel at 20°C. At low concentrations the salt is completely ionized, the coefficient of diffusion measured being that of HPO_4^{2-} in the presence of Na^+. F. LACHMAN

539.217

7783. Diffusion in bimetal vapor-solid couples. R. W. Balluffi and L. L. Seigle. *J. appl. Phys.*, **25**, 607–14 (*May*, 1954).

The intrinsic diffusivities of individual components in several binary systems have been determined with vapour-solid type diffusion couples. In this type of couple a high vapour-pressure component is diffused from the vapour phase into a slab of lower vapour pressure initially containing inert markers on its surface. Diffusivities may then be calculated from marker movement and diffusion-penetration curve data. Equations necessary for analysis of such couples are developed. The α brass, copper-nickel and silver-gold systems were investigated. Observations of polygonization during diffusion and dimensional changes normal to the diffusion direction were also made. Porosity formation, which occurred only in the vapour-solid silver-gold couples, was investigated in detail and was compared to porosity formation in corresponding sandwich couples. The general use and limitations of such couples in diffusion studies are discussed. A.

539.217 : 541.133

7784. Self-diffusion and ionic conductivity in sodium bromide. H. W. Schamp, Jr and E. Katz. *Phys. Rev.*, **94**, 828–36 (*May* 15, 1954).

The self-diffusion coefficient D_{Br} of radioactive bromide ions in sodium bromide (melting point 755°c) has been measured in the temperature range 360–688°c, and the ionic conductivity of sodium bromide in the range 340–600°c. At high temperatures, above 450°c, the results of the diffusion measurements are quantitative and are expressible as $D_{Br} = 50e^{-2\cdot02/kT}$ cm²/sec. A comparison of diffusion and conductivity measurements yields the following results. The activation energy for migration of a Na-ion vacancy is 0·80 ± 0·03 eV. The activation energy for the formation of a separated Na-ion vacancy and a Br-ion vacancy is 1·68 eV. The activation energy for the migration of a Br-ion vacancy is 1·18 eV. The transport numbers for the salt can be expressed as $n_{Br} = 11\cdot5e^{-0\cdot36/kT}$. At lower temperatures the diffusion coefficient contains a large experimental uncertainty. It is shown, however, that the measured values can only be higher than the actual diffusion coefficients. Comparison of the measured diffusion coefficient of the bromide ion with the diffusion coefficient of the sodium ion calculated from the ionic conductivity shows that the diffusion coefficient of the bromide ion is not more than 2–3% as large as the diffusion coefficient of the sodium ion, whence it must be concluded that in the whole temperature range investigated there is no evidence for the presence of pairs of vacancies. A.

539.217 : 548.7

7785. Photon-induced diffusion in thin films and single crystals of potassium iodide. C. J. Delbecq and P. H. Yuster. *J. chem. Phys.*, **22**, 921–5 (*May*, 1954).

Thin films of potassium iodide have been prepared at both room and liquid nitrogen temperatures. Absorption spectra are presented which show that films deposited at liquid nitrogen temperature are quite disordered, but after warming to room temperature are very similar to those films deposited at room temperature. Evidence is given which shows that in thin films and also in single crystals of potassium iodide diffusion is promoted by the absorption of light. It is proposed that diffusion is caused by point thermal spikes at the absorbing centres. A.

539.217.1

7786. Pore-size distribution of porous iron. P. Zwietering and H. L. T. Koks. Letter in *Nature* [*London*] **173**, 683–4 (*April* 10, 1954).

By measuring the volume of mercury forced into

the interstices of porous iron as a function of pressure a distribution of pore sizes is calculated. The method is suitable for pore sizes down to 100 Å. W. M. LOMER

539.219.2

7787. Optical studies of ring cracks on glass. S. TOLANSKY AND V. R. HOWES. *Proc. Phys. Soc.* [*London*] *B*, **67**, 467–72 (*June*, 1954).

The surface distortions accompanying the familiar ring crack Hertzian cones formed on glass by local pressure were studied optically for four different optical glasses. The ring cracks were produced both with a rounded diamond and a steel ball indentor. The surface profiles were studied both by interferometry and with the light profile microscope. A frequent observation was the occurrence of multiple circular ring cracks surrounding a flat, slightly depressed disk, as a series of annular pile-ups of glass, usually not exceeding a height of 1500 Å. Surface profiles are illustrated for individual cracks on each of the glasses. The area of contact between glass and steel at the onset of a ring crack on a typical glass was revealed by an interferometric method. The crack appears to start at the rim of the circle of contact and sets in at a mean pressure of 14 000 kg cm^{-2}. A.

539.219.2

7788. Oriented ring cracks on diamond. S. TOLANSKY AND A. HALPERIN. *Proc. Phys. Soc.* [*London*] *B*, **67**, 473–6 (*June*, 1954).

Two octahedral faces of a large very perfect diamond have been studied optically and interferometrically. On the surfaces have been found a hundred crater-like features each about 50 μ wide and a few hundred ångström units high. It is shown that these are the analogue on diamond of the long familiar ring crack Hertzian cones formed on glass subject to local pressure. It is possible that impact with other diamonds is responsible for the ring crack formation. The cracks on the diamond are crystallographically oriented and the profiles of some are measured interferometrically. A.

539.232

7789. Structure of zinc surfaces oxidized at different temperatures. M. MATYÁŠ. Letter in *Czech. J. Phys.*, **3**, 166–7 (*June*, 1953) *In German.*

Thin layers of Zn, oxidized in air at room temperature, show two structures on electron diffraction examination. One is the normal ZnO structure, the other a similar structure with different unit cell dimensions. The latter structure is attributed to the influence of the Zn structure on the first formed oxide layers. The modification recrystallizes at about 250°C to form the normal structure. The effect is believed to be related to a change in oxidation velocity reported at 225°C by Vernon *et al.* [*J. Inst. Metals*, **65**, 301 (1938)]. J. THEWLIS

539.232 : 535.51

7790. The study of the anodized Al_2O_3 films on aluminium by the polarimetric method. A. VAŠÍČEK. Letter in *Czech. J. Phys.*, **3**, 167–8 (*June*, 1953).

The measurement in a polarimetric spectrometer is described of the (considerable) change in ellipticity of the light reflected from an optically plane aluminium mirror undergoing anodization in solutions contained in a hollow triangular prism. Extension of the method to the study of oxide films on metals in general is suggested. W. GOOD

539.232 : 539.27

7791. The overgrowth of Cu_2O on the surface of copper during oxidation. M. MATYÁŠ. Letter in *Czech. J. Phys.*, **3**, 260 (*Sept.*, 1953) *In Russian.*

Electron diffraction examination of Cu oxidized in air up to 250° showed that the resulting layer of Cu_2O lay with (111) parallel to the (100) plane of the Cu base. The [112] direction of the Cu_2O (repeat distance 5·1 Å) was parallel to the [100] axis of the Cu (repeat distance 2·52 Å). The Cd–CdO system is analogous. A. L. MACKAY

539.234

7792. On the lattice anomaly of bismuth film deposited from its vapour. Y. FUJIKI AND R. SUGANUMA. Note in *J. Phys. Soc. Japan*, **9**, 144–5 (*Jan.–Feb.*, 1954).

Electron diffraction measurements at room temperature showed that the spacing and the axial ratio c/a of films deposited in vacuum on quartz or collodion differed respectively by $-0{\cdot}15\%$ and $+1{\cdot}48\%$ from the normal bulk values of Bi. At temperatures ~ 240°C structure loosening occurs [Abstr. 8717 (1953)] and an amorphous halo pattern is superposed on the crystalline pattern, which now yields a negative value for $\Delta(c/a)$, but the same value for Δa. The structure is thus nearer to cubic than is normal and it is suggested that crystals do not change their structure abruptly but pass through such states as this in the process of structure loosening. A. D. LE CLAIRE

539.234 : 537.311.33

7793. Transparent semiconducting oxide films. R. E. AITCHISON. *Austral. J. appl. Sci.*, **5**, 10–17 (*March*, 1954).

Some experimental details are presented on the preparation and electrical properties of transparent electrically conducting oxide layers on glass. The layers consist essentially of stannic oxide, or a mixture of stannic oxide and other oxides. Surface resistances of from 50 to 10 000 Ω/square can be obtained, combined with high optical transparency. Measurements are given on the effect of impurity additions on the resistivity and its temperature dependence. A.

539.26 : 539.374

7794. The determination of micro-strains in plastically deformed polycrystalline bodies. B. YA. PINES AND N. G. BEREZNYAK. *Zh. tekh. Fiz.*, **24**, *No.* 2, 329–36 (1954) *In Russian.*

Broadened X-ray powder lines from wires of strained W and Ta, taken under conditions giving the minimum instrumental broadening were photometered. Fourier transformations were applied to the resulting intensities. It is deduced that the strain increases linearly up to 100–150 Å and after that tends to a limiting value. Using known elastic constants the limits of flow were found to be approx. 90 kg/mm^2 for W and 70 kg/mm^2 for Ta. Deformation is therefore homogeneous only over regions of dimensions 100–150 Å. A. L. MACKAY

539.26 : 539.5

7795. The relationship between structure and mechanical properties during the hardening of aluminium silver alloy. B. Belbeoch and A. Guinier. *C.R. Acad. Sci.* [*Paris*] **238,** 1003–5 (*March* 1, 1954) *In French.*

A low angle diffuse X-ray study of the alloy (38% Ag) whose mechanical properties have been studied by Köster [*Zeitschrift für Metallkunde*, **43,** 193 (1952)]. Isochronous curves of hardness against temperature show first a broad maximum, then a minimum and then a narrower and higher maximum. The first maximum (cold hardening) is found to correspond with the formation of Ag-rich nuclei, and the second (hot hardening) with the appearance of thin precipitate plates of Al_2Ag, both as revealed by X-rays. The details of the hardening curves are further discussed in relation to these two structural features. A. D. LE CLAIRE

539.27

7796. An improved replica technique for electron microscopy of paint films. A. S. Powell, L. R. LeBras, E. G. Bobalek and W. von Fischer. *J. appl. Phys.*, **25,** 757–60 (*June*, 1954).

Improved polyvinyl alcohol/silica replica techniques are described which allow for more accurate examination by electron microscopy of pigment-derived microstructure in paint films. These methods complement the silver-silica techniques which are preferable only for studying much finer details, such as molecular configurations and small distortions of the resinous binder. Procedures have been developed for stripping unaltered baked enamel films from tin plate. The underside of these free films can be examined with the improved replica techniques and it is possible to study differences in top and bottom structure of paint films. Applications of the refined replica techniques in the study of paint films are presented. A.

539.27 : 541.183.1

Field emission microscope for the study of structure and adsorption on metal surfaces. *See Abstr.* 7838

539.27 : 778.34

Nuclear emulsions for electron microscopy. *See Abstr.* 7980

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.32 : 537.228.1

7797. Elastic and piezoelectric coefficients of dipotassium tartrate (DKT). R. Bechmann and S. Ayers. *Proc. Phys. Soc.* [*London*] *B*, **67,** 422–6 (*May*, 1954).

A new determination has been made of these coefficients and of their behaviour with temperature. A table is included comparing the properties of some zero-temperature-coefficient cuts of DKT, EDT and quartz. A.

539.374

7798. Plastic deformation in beams under distributed dynamic loads. J. A. Seiler and P. S. Symonds. *J. appl. Phys.*, **25,** 556–63 (*May*, 1954).

Plastic deformations in beams caused by symmetric dynamic loads distributed over finite lengths are considered. The analysis is based on the assumption of "plastic-rigid" behaviour, so that the results should be valid when plastic deformations are sufficiently large. The final deformations for distributed loads are found not to differ much qualitatively from those to be expected for concentrated loads. However, the magnitude of the deformation decreases rapidly as the length of the loaded area increases from zero, for given load pulses. Thus the simplifying assumption of a mathematically concentrated load may cause a considerable overestimate of the final deformation. A.

539.374 : 536.37

7799. On the heating of tensile rods on account of plastic deformation. P. Täubert. *Z. angew. Phys.*, **6,** *No.* 3, 108–12 (1954) *In German.*

After showing that the order of magnitude of heating Q is 100 deg, the problem is treated mathematically by determining the temperature distribution in a rod taking into account the thermal conduction in the axial direction and the heat transfer to the surroundings. An expression for Q is derived in terms of two dimensionless parameters and the values of Q for various values of these parameters are shown graphically and discussed. A numerical example is given for the case of a Cu wire, 1 mm dia. and 30 mm long, which is broken in 5 sec. S. Weintroub

539.4.011.2

7800. Delayed yield and strain rate and temperature dependence of yield point in iron. T. Yokobori. *J. appl. Phys.*, **25,** 593–4 (*May*, 1954).

A unified explanation of delayed yield and of strain rate and temperature dependence of yield point in iron was attempted on the basis of the Cottrell locking theory, taking internal stress into account. The energy of a dislocation required to fit existing data is small by an order of magnitude compared with the value theoretically estimated by Mott and Nabarro. The distance, calculated from the value of internal stress, between dislocations assembled at a grain boundary is of a reasonable order of magnitude. It is suggested that the mechanism of yielding may change from Cottrell type to Mott–Nabarro or Frank–Read type when applied stress falls below some limiting value. A.

539.4.016

7801. Hardness plateaus and twinning in explosively loaded mild steel. J. Pearson and J. S. Rinehart. *J. appl. Phys.*, **25,** 778–81 (*June*, 1954).

Hardness measurements were made along radii of circular cross-sections of an annealed thick-walled low-carbon steel cylinder internally loaded with an explosive charge. The degree of work-hardening in the cylinder wall was found to decrease nonuniformly with an increase in distance from the surface in contact with the explosive. Each hardness v. distance curve exhibited a series of plateaux along which the hardness remained constant. The plateaux appear to be related to Neumann bands which are present in the steel. The maximum number of twin directions in a single grain increases with the magnitude of the stress. The presence of the hardness plateaux and the increase in the number of twin directions with

hardness and stress level point to the existence of critical stresses for twinning. A.

539.4.016.2

7802. On the change of density of copper single crystals by cold working. S. Issiki and H. Kimura. *J. Phys. Soc. Japan*, **9**, 139–40 (*Jan.–Feb.*, 1954).

The authors' measurements of the changes ($\sim -0{\cdot}00020$ in single crystal cylinders compressed 15%) can be equally well accounted for quantitatively either as due to the creation of lattice strain employing Zener's theory or of vacancies using an estimated value of their formation energy. A. D. LE CLAIRE

539.434 : 539.4.016

7803. On the theory of work hardening of metals in creep. G. Lucas and K. Lücke. *Z. angew. Phys.*, **6**, *No.* 2, 64–70 (1954) *In German.*

The rival theories of exhaustion creep, and stress-interaction hardening are discussed. It is shown that the exhaustion theory can explain most of the observations if a certain assumption concerning the distribution of centres where slip occurs is made. In particular, Andrade's creep law, and the dependence of the constants of the law on temperature, can be explained. A brief discussion of the possible reasons for the required exponential distribution of sources, based on the statistics of the probable length of Frank–Read sources, is given. W. M. LOMER

539.621

7804. Friction of clean metals and oxides with special reference to titanium. E. S. Machlin and W. R. Yankee. *J. appl. Phys.*, **25**, 576–81 (*May*, 1954).

The friction coefficients of freshly cut surfaces in inert atmosphere are compared with values on the same surfaces later exposed to air. The kind of metal or oxide comprising the friction couple was also varied. From experimental data it was concluded that: (1) Solid-phase welding accounts for almost the entire magnitude of the static friction coefficient for metal-metal couples. (2) Fe–Ag does not solid-phase weld, other insoluble couples examined do weld. (3) A measure of solid-phase weldability appears to be the quotient of the work of adhesion and the shear strength of the weaker couple. (4) Titanium does not solid-phase weld to crystalline oxides to any greater extent than copper. (5) Freshly cut titanium solid-phase welds to other metals in frictional contact. The degree of welding is independent of the atmosphere (air, nitrogen or argon) or the time (less than 24 hours) at room temperature in such atmospheres. This behaviour is contrary to that experienced with iron or copper. With the latter couples less than five minutes' exposure of a freshly cut surface to air is sufficient to markedly reduce the degree of solid-phase welding. (6) The seizability of titanium is probably due to the lack of resistance, of the contaminant film formed on it in air, to penetration or wear in frictional contact. A.

539.67

7805. An apparatus for the accurate measurement of internal friction. J. R. Pattison. *Rev. sci. Instrum.*, **25**, 490–6 (*May*, 1954).

An electronic instrument has been developed for the measurement of internal friction to a high level of accuracy. The device is actuated by an input signal consisting of a voltage-time decay waveform, with the necessary condition that the decay should follow an exponential law. The operation is both automatic and rapid so that the apparatus is suitable for investigating changes in damping when a given dependent parameter is varied. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123 : 536.7

7806. Equilibria in the formation of molybdenum and thorium iodides from the elements. T. L. Allen and D. M. Yost. *J. chem. Phys.*, **22**, 855–9 (*May*, 1954).

An investigation has been made of the reaction of molybdenum and iodine to form molybdenum diiodide in the temperature interval from 1086°K to 1914°K, and the reaction of thorium and iodine to form thorium tetraiodide in the temperature interval from 1395°K to 1706°K. Thermodynamic properties of molybdenum diiodide and thorium tetraiodide were determined from measurements of the equilibria in these reactions. For the reaction $Mo(s) + 2I(g) = MoI_2(g)$ at 1200°K, $\Delta F^0 = -13{\cdot}6$ kcal/mole, $\Delta H^0 = -25{\cdot}0$ kcal/mole, and $\Delta S^0 = -9{\cdot}5$ cal/mole °K. For the reaction $Th(s) + 4I(g) = ThI_4(g)$ at 1500°K, $\Delta F^0 = -83$ kcal/mole. Using an estimated value for ΔS^0 of -82 cal/mole °K, $\Delta H^0 = -206$ kcal/mole. The average Mo — I bond energy in $MoI_2(g)$ and the average Th — I bond energy in $ThI_4(g)$ are both 89 kcal/mole. A.

541.123.012.5 : 532.61

7807. Separation of a mixture of liquid substances, insoluble in water, by isothermal superficial distillation. M. Abribat, H. L. Rosano and G. Vaillet. *C.R. Acad. Sci.* [*Paris*] **238**, 1219–21 (*March* 15, 1954) *In French.*

The components of a mixture of liquids can be separated by spreading drops of the mixture on a surface of a liquid in which the mixture is insoluble, and which is in capillary connection with a flowing surface of the pure liquid. A plot of the surface tension of the contaminated surface against time consists of a number of horizontal "waves" of decreasing height, whose height represents the surface tension of the individual components, while their length is proportional to the percentage of the relevant component in the mixture. When carried out on a polymer, a sloping curve of surface tension against time is obtained, with no breaks or horizontal portions, suggesting a continuous separation of fractions

of different molecular weight; the slope may bear some relation to the distribution of molecular weights in the polymer. R. C. MURRAY

541.123.012.5 : 536.7

7808. Thermodynamics of equilibrium in the ultracentrifuge. T. F. YOUNG, K. A. KRAUS AND J. S. JOHNSON. *J. chem. Phys.*, **22**, 878–80 (*May*, 1954).

An exact equation has been derived which can be used for the determination of the ratio of the activity of substance i in a solution of molality m_β to the activity in a solution of molality m_α. Here m_β and m_α are the respective molalities observed at two positions x_β and x_α within a two-component solution which has come to equilibrium in an ultracentrifuge. The calculation involves the densities of the solution at all positions between x_β and x_α and the partial molal volumes of i for the two molalities m_β and m_α. For each of these molalities partial volumes are required for the range of pressure between the equilibrium pressure acting on the solution of that molality and the pressure (ordinarily one atmosphere) of interest to the investigator. Some information concerning a solution containing more than two components can be derived from ultracentrifugal experiments if adequate density data are available. A.

541.123.2 : 539.155.2

7809. Isotopic exchange of oxygen in the systems water-silica and oxygen-silica. D. A. HUTCHISON. Letter in *J. chem. Phys.*, **22**, 758–9 (*April*, 1954).

In the latter system isotopic exchange is found not to occur up to 1000°C. Data (which are given) for the rate of the isotopic reaction between H_2O^{18} and SiO_2^{16} at 960°C indicate a homogeneous one between dissolved silica and the water, whilst at 750°C the results (not given in detail) are interpreted in terms of a predominant surface rate-controlling reaction.

W. GOOD

541.124

7810. Reactions of free radicals with aldehydes. II. The reactions of methyl radicals with propionaldehyde. D. H. VOLMAN AND R. K. BRINTON. *J. chem. Phys.*, **22**, 929–33 (*May*, 1954).

For previous part, see Abstr. 1202 (1953). The reaction of radicals derived from the thermal decomposition of di-*t*-butyl peroxide with propionaldehyde in the gas phase has been studied. The gaseous products were carbon monoxide, methane, ethane, propane, butane and ethylene. A mechanism to account for the induced chain decomposition and product formation involving H atom abstraction by radicals and radical decomposition, combination and disproportionation is given. The energetics of H atom abstraction by methyl and ethyl were similar and lead to an activation energy of about 7·5 kcal/mole and a steric factor of about 10^{-3}. These values are in good agreement with those found for H atom abstraction from acetaldehyde. Evidence is presented that H atom abstraction takes place with the carbonyl attached H for both acetaldehyde and propionaldehyde. A.

541.124 : 536.24

Heat transfer in a flow accompanied by a chemical reaction. *See Abstr.* 7355

541.126

7811. Measurements of energy in the explosions of the initiating explosives. W. NODDACK AND E. GROSCH. *Z. Elektrochem.*, **57**, *No.* 8, 632–6 (1953) *In German.*

A piezoelectrical method has been used for the investigation of the energetical characteristics and change in time of explosions and detonations of AgN_3, PbN_6, HgN_3 and $Hg(CNO)_2$. The temperatures of explosion have been calculated, the maximum gas pressures measured and the pressure and energy yield determined. F. LACHMAN

541.126

7812. Optical investigations of the adiabatic combustion of solid propellants. F. RÖSSLER. *Z. angew. Phys.*, **6**, *No.* 4, 175–82 (1954) *In German.*

A description of the measurement in a bomb of the pressure, light absorption and emission, and temperature during the combustion of nitrocellulose and nitroglycerine powders is given. The continuous radiation which increases and then decreases in intensity during the combustion is due to soot particles the concentration of which changes with time; it yields temperature values which lie considerably above those thermodynamically calculated. An analysis of the band spectra shows the presence of the radicals CN, OH, NH and NO. Chemi-luminescence is observed under certain conditions and is ascribed to oxidation of CO by O atoms. The speed of movement of the gases is studied by cinematographic methods and found to be 0·5–1 m/sec.

W. GOOD

541.126 : 534.222.2

7813. Chemical reactions in strong shock waves. E. F. GREENE. *J. Amer. Chem. Soc.*, **76**, 2127–31 (*April* 20, 1954).

Strong shock waves, generated in shock tubes, provide a promising way of studying high temperature chemical reactions in gases. The heating by the shock wave is uniform, extremely rapid and intense so that the temperature may rise many thousands of degrees in a fraction of a microsecond. Observations of the effects of this heating on compounds like CH_3I and BrCN have shown extensive decomposition into such radicals as CH, C_2 and CN. A.

541.126 : 534.222.2

Spherical propagation of detonation in acetylene-air mixtures. *See Abstr.* 7205

541.126 : 535.343.1

Absorption spectroscopy of explosions. *See Abstr.* 7296

541.127

7814. Reaction velocity near equilibrium. P. VAN RYSSELBERGHE. Letter in *J. chem. Phys.*, **22**, 761 (*April*, 1954).

Reactions of the type $A + B \rightarrow M + N$ are regarded as involving forward and reverse complexes C_f and C_r of the same gross compositions. Near equilibrium, approximations hold, which lead to the same relation as given by Zwolinsky and Marcus [Abstr. 5066 (1954)] between the net reaction velocity, the equilibrium constant for the formation of C_f, and the affinity. The present derivation shows clearly the role of C_f. A. J. TAYLOR

541.127

7815. The reaction between fluorine and chlorine dioxide, a homogeneous, bimolecular reaction. P. J. Aymonino, J. E. Sicre and H. J. Schumacher. Letter in *J. chem. Phys.*, **22**, 756–7 (*April*, 1954).

The reaction, investigated at −26°, −36° and −46°c, and in a pressure range of 50–500 mm Hg, was found to be homogeneous and bimolecular with an activation energy of $8{\cdot}5 \pm 0{\cdot}4$ kcal and a steric factor of $3{\cdot}0 \times 10^{-4}$. W. GOOD

ELECTROCHEMISTRY 541.13

541.133

7816. Theory of the Wien effect in solutions of electrolytes. H. Falkenhagen and G. Kelbg. *Z. Elektrochem.*, **57**, *No.* 7, 609–14 (1953) *In German.*

An attempt at finding the part played by the ionic radii and the density of ionic coverage in the formulae for the dependence of the conductivity of strong electrolytes on potential. When developing Falkenhagen's ideas [*Physikalische Zeitschrift*, **32**, 353–65 (*May* 1, 1931)], one obtains for the relaxation force a qualitative formula; the quantitative treatment, unlike Wilson's theory (W. S. Wilson, *Dissertation*, Yale University, 1936), does not yield a definite formula. This is due to a very complicated character of boundary conditions on the surface of the hydrated ions. F. LACHMAN

541.133.08

7817. A new method for measurement of the high field conductance of electrolytes (the Wien effect). J. A. Gledhill and A. Patterson, Jr. *J. phys. Chem.*, **56**, 999–1005 (*June*, 1952).

A new method utilizing a differential pulse transformer bridge is described for the measurement of conductance of electrolytes under high fields. This method is useful not only for high-field work, but also for impedance measurement in general, and for low-field conductance work when it is desirable to avoid the platinization of electrodes required for the satisfactory operation of the usual conductance bridges. The bridge method is a general one for all impedance measurements and for use at frequencies and with pulses or waveforms limited only by the design of the transformer. Measurements of the high field conductance of magnesium and zinc sulphates and of acetic acid indicate that repeated measurements on the same solution at the same value of field give rise to differences in the per cent fractional high-field conductance quotient, $\Delta\lambda/\lambda_0(\%)$, of 0·03 or less; in other words, the precision of measurement is 0·03%, absolute. Preliminary measurements are presented for these two salts and for the acid which indicate conformity with the results of Wien and his co-workers. A.

541.133.1 : 536.7

7818. The thermomechanics of electrolysis. J. E. Verschaffelt. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 3, 219–24 (1954) *In French.*

See also Abstr. 4642 (1953). The author applies his theory of the transference phenomena to the study of the electrothermal equilibrium in a substance undergoing electrolytic dissociation. The results of calculation are applied to the electrical conductivity involving electrons. The heat of reaction, corresponding to the charge developed as a result of the dissociation of the fluid in two reservoirs of fluids having different temperatures and forming an open circuit, is called the *heat of the charge*. F. LACHMAN

541.135

7819. Concentration dependence of differential capacity in electrolytes at the electrocapillarity maximum. J. R. McDonald. Letter in *J. chem. Phys.*, **22**, 763–4 (*April*, 1954).

A theoretical expression, the derivation of which is to be published later, showing the dependence of differential capacitance per unit area of the interface, metal electrode-solution, on the potential relative to the electrocapillarity max. potential is used with recent experimental data to calculate for five concentrations of NaF at 25°c, the differential dielectric constant of the charge-free layer which lies between the electrode and the diffuse space-charge layer of ions. The thickness of the charge-free layer is estimated to be 3·1 Å, which is approx. equal to the sum of the radius of Na^+ and the diameter of the hydrating water molecule. W. GOOD

541.135 : 537.525.8

On glow discharge electrolysis with alternating current. *See Abstr.* 7472

541.135.4

7820. A new effect in the electrolytic transference in solid alloys. W. Seith and H. Wever. *Z. Elektrochem.*, **57**, *No.* 10, 893–902 (1953) *In German.*

The Kirkendall effect [Smigelskas and Kirkendall, *Transactions of the American Institute of Mining and Metallurgical Engineers*, **171**, 130 (1947)] has been found to occur during the electrolytic transference experiments with alloys in the range of the (Hume–Rothery) β-phase of Cu_3Al. In the solid state, both Cu and Al have been found to wander to the anode, Al displaying in relation to Cu a displacement toward the cathode. It has been possible to calculate from the results both the "total transference number" (U_{CuAl}, the amount of matter, in gram-ions, transferred by 1 F in relation to a system of co-ordinates fixed at the Cu electrodes) and the "relative transference number" ($U_{Al(Cu)}$, the amount of Al, in g.ions, transferred in relation to Cu by 1 F in the same system of co-ordinates). The latter magnitude has been found to average 3×10^{-8} g.ions/F at the conditions of the experiment. F. LACHMAN

541.135.5

7821. Reduction of carbon dioxide on mercury cathodes. T. E. Teeter and P. Van Rysselberghe. Letter in *J. chem. Phys.*, **22**, 759–60 (*April*, 1954).

Polarization curves in solutions of KCl, NH_4Cl, $NaHCO_3$ and $N(CH_3)_4Br$ through which purified CO_2 is passed continuously show sudden increases of current at cathodic potentials equal to those at which polarographic currents in the same solutions begin to increase. These potentials are appreciably lower than those at which the current begins to increase when the CO_2 is replaced by N_2. The only reduction product which could be identified was formic acid. W. GOOD

541.136.3 : 621.355.5

7822. Thermodynamic properties of the PbO_2–Zn accumulator in acid electrolyte. F. Accascina and M. de Rossi. *Ricerca sci.*, **24**, 42–8 (*Jan.*, 1954) *In Italian.*

The electromotive force of the PbO_2–Zn/Hg cell has been accurately determined. The value obtained as the average of different determinations on 5 cells resulted in: $E_{18} = 2552$ V. The thermal coefficient of the cell has been determined at 18°C and resulted in $1{\cdot}6 \times 10^{-4}$ V/deg. The heat of the reaction presumably taking place in the cell has been computed on the basis of thermochemical data found in literature, and by referring them to the experimental conditions. The same magnitude has been computed by means of the values of E and dE/dT measured by the authors. The results for ΔH obtained from the thermochemical and electrochemical data show a satisfactory agreement, especially taking into account the various sources of error which might affect the measurements. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

7823. Formation of AgCl on silvered NaCl crystals. W. van der Vorst, W. Dekeyser and O. Goche. Letter in *Naturwissenschaften*, **41**, *No.* 5, 116 (1954).

An Ag film was deposited by evaporation on crystals previously exposed to X-rays. No change occurred in the Ag if the crystals were kept in the dark up to 120°C but at 150°C the crystals bleached in two hours and the Ag was converted into a white layer. Electron diffraction showed AgCl lines. The explanation is that electrons can only leave the metal when the difference between the work function of the metal and the electron affinity of the crystal is not too large compared with kT. Transfer of electrons to the crystal produces a surface-charge layer which attracts positive holes. The latter combine with Ag to give AgCl. J. EWLES

541.14

7824. The photolysis of ammonia at 1849 Å in a flow system. C. C. McDonald, A. Kahn and H. E. Gunning. *J. chem. Phys.*, **22**, 908–16 (*May*, 1954).

An investigation has been made of the photolysis of ammonia at 1849 Å in a flow system at room temperature. The products of the reaction were found to be hydrazine, hydrogen, and nitrogen. The rate of decomposition of ammonia was independent of the linear flow rate, but depended upon the ammonia pressure in the reaction zone. The fraction of ammonia decomposed which was recovered as hydrazine, while independent of ammonia pressure, increased markedly with increasing linear flow rate from zero in the static system to 0·84 at a linear flow rate of 1750 cm/sec. It was found that the quantum yield of ammonia consumption under flow conditions was consistently higher by a factor of approximately two than for the static conditions at the same pressures. A separate system was used to determine the extinction coefficient of ammonia at 1849 Å over the pressure range of the experiments. The value obtained was $1{\cdot}21 \times 10^3$ litres-mole^{-1}-cm^{-1}. A mechanism has been proposed which is in qualitative agreement with the observed facts. A.

541.14

7825. Photochemical activity of salts of uranium in solutions at the temperature of liquid nitrogen. S. Freed and K. M. Sancier. *J. chem. Phys.*, **22**, 928–9 (*May*, 1954).

Anhydrous chlorides of hexavalent (UO_2^{++}), quadrivalent, and trivalent uranium ions are photochemically active when in a solution fluid at 77°K. The solvent consisted of 10% *n*-propanol, 45% propane, and 45% propene. It was shown spectroscopically and also chemically that quadrivalent uranium was reduced to the trivalent form. There were indications that trivalent and hexavalent uranium were transformed photochemically to the tetravalent state. A.

541.141.1

7826. Energy balance of the silver bromide photolysis. W. Noddack and G. Eckert. *Z. Elektrochem.*, **57**, *No.* 8, 696–700 (1953) *In German.*

The amounts of heat observed during the irradiation of an AgBr acceptor with wavelengths 4358 and 3650 Å have been measured using a special thermopile. The heat of the reaction $[Ag^+Br^-]_{\text{cryst}} = [Ag]_{\text{nucleus}} + [Br]_{\text{atom}} - Q$ has been calculated as $Q = 17{\cdot}1$ kcal, which corresponds to 16 700 Å. It has been possible to calculate from these values the centre of gravity of the Herschel band as $\lambda = 6950$ Å, in agreement with observation. F. LACHMAN

541.15

7827. Atomic hydrogen hyperfine structure in irradiated acids. R. Livingston, H. Zeldes and E. H. Taylor. Letter in *Phys. Rev.*, **94**, 725 (*May* 1, 1954).

Irradiation of $HClO_4$, H_2SO_4 and H_3PO_4 at 77°K with Co^{60} γ-rays gave free-radical paramagnetic resonance absorption at 8000 gauss and 23 000 Mc/s. Some of the product was identified as H atoms by the peaks about 250 gauss on each side of the central $g = 2{\cdot}0$ lines; the exact separations gave $\nu_H = 1405$ to 1424 Mc/s according to environment, in essential agreement with the atomic beam value of 1420·410 Mc/s. Free D was also detected using D_2O dilutions. D. H. WHIFFEN

541.15 : 538.222

Detection of paramagnetic resonance in certain irradiated organic substances. *See Abstr.* 7569

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.182.2

7828. Filtration of monodisperse electrically charged aerosols. G. G. Goyer, R. Gruen and V. K. LaMer. *J. phys. Chem.*, **58**, 137–42 (*Feb.*, 1954).

Uniform particle size liquid aerosols were charged electrically by passage through a wire to cylinder corona discharge. The unipolar droplets carried a positive charge ranging from 25 to 150 electronic

charges depending on the intensity of the charging field (5–18 e.s.u.) and the radius of the aerosol droplets (0·25–0·55 μ). Charge and radius were determined with a Millikan-type oil drop apparatus. The maximum theoretical charge was not obtained and a distribution of charge on uniform particle size particles was observed. Factors affecting the incompleteness and non-uniformity of charge are: electric winds, turbulent flow, non-uniform velocity of flow and charging times, inhomogeneity of the field gradient. Although a completely uniform charge was not obtained, a sufficiently well defined charge range was obtained for the particle radii studied, to yield reproducible filtration at a given size as a function of the average particle charge. Filtration of charged dioctyl phthalate monodisperse aerosol droplets through Chemical Corps No. 5 filters was studied at two linear velocities, 2·7 and 28 cm/sec. An appreciable decrease in penetration is observed upon charging. As would be expected, this decrease is larger at smaller linear velocities. The time of transit of the charged particles through the filter layer is an important factor. The effect of charges on filter penetration is larger the smaller the droplet size. A.

541.182.2 : 537.228.2

The distortion of aerosol droplets by an electric field. *See Abstr.* 7404

541.183

7829. A new method of determining the partial coefficients of thermal accommodation. K. Schäfer and K. H. Riggert. *Z. Elektrochem.* **57**, *No.* 8, 751–7 (1953) *In German.*

A new "band-wire" method is developed for the determination of the partial accommodation coefficients, its use being not limited to gases and definite ranges of temperature. Using Au surface, the following gases have been investigated in the temperature range 0–100°C: N, O, CO_2, NO, and Freon 13. The values obtained agree with those of other authors.

F. LACHMAN

541.183

7830. Statistical theory of adsorption. T. Tanaka. *Mem. Fac. Sci. Kyusyu Univ. B*, **1**, 65–74 (*March*, 1953).

Theoretical. The method of characteristic value is applied to the adsorption of gaseous molecules on a solid surface. The maximum characteristic value is first calculated by a perturbation method and then the partition function per lattice point and the amount of absorption are both represented as power series with two parameters depending on the temperature and pressure of the gaseous phase. When the system contains an extremely large number of molecules the adsorption isotherm splits into three distinct parts, which is in good agreement with the behaviour of the so-called critical adsorption phenomenon. J. IBALL

541.183

7831. Determination of adsorption energy heterogeneity of solid surfaces. J. M. Honig and E. L. Hill. *J. chem. Phys.*, **22**, 851–4 (*May*, 1954).

A revision of the theory for the distribution of adsorption energies among the surface sites of a solid is presented. It is postulated that the distribution function for the adsorption energies is independent of the temperature. With this requirement, and a knowledge of the pressure-temperature dependence of empirical isotherm data, it is possible to determine simultaneously the distribution function and the dependence of the partition function of the adsorbed phase on the adsorption energy. Several examples are presented in illustration of the theory. A.

541.183

7832. Hopping molecules and surface migration. S. Kruyer. *Proc. K. Ned. Akad. Wetensch. B*, **56**, 274–9 (*May–June*, 1953).

Treating surface migration as a problem of random walk the author derived a relation for the diffusion constant of the migration along the surface in the case of localized adsorption at low degrees of occupation. This relation is shown to be equivalent to the one derived by Clausing for mobile adsorption at low degrees of occupation. The influence on the total flow through capillaries exerted by the surface migration in the case of localized adsorption at low degrees of occupation is discussed. A.

541.183 : 536.75

7833. Entropy and mobility of adsorbed molecules. III. Hydrogen and oxygen on charcoal. J. H. de Boer and S. Kruyer. *Proc. K. Ned. Akad. Wetensch. B*, **56**, 236–44 (*May–June*, 1953).

For Pt II, see Abstr. 6094 (1954). The adsorption of hydrogen on charcoal at very low temperatures is caused by van der Waals' forces. The translation movement of the adsorbed molecules is somewhat restricted. At higher temperatures hydrogen seems to be adsorbed by chemical forces. It cannot be decided whether the molecules are bound in a position parallel to the surface, nor can it be decided whether a splitting up into atoms has taken place. The adsorption of oxygen on charcoal at temperatures between 60°K and 90°K is of a physical character. The molecules move freely over the surface at the upper end, but are somewhat restricted in their movements at the lower end of this temperature range. A model of two-site adsorption is introduced and the entropy relations connected with this model are discussed. A.

541.183 : 536.75

7834. Entropy and mobility of adsorbed molecules. IV. Aliphatic hydrocarbons on charcoal. J. H. de Boer and S. Kruyer. *Proc. K. Ned. Akad. Wetensch. B*, **56**, 415–26 (*Nov.–Dec.*, 1953).

The adsorption entropies of the normal saturated aliphatic hydrocarbons, when adsorbed on charcoal, show that, at temperatures between 40°C and 200°C, the lower terms behave as two-dimensional gases. The molecules move freely over the surface and retain their free rotations and inner vibrations. The greater the number of carbon atoms in the molecule, the higher the degree of occupation, and the lower the temperature, the greater the tendency to some restriction of the free movement. A study of the molecular area of the adsorbed molecules suggests that even the larger molecules of n-C_7H_{16} retain their rotation in all directions. The loss of translational entropy of the larger molecules must be ascribed

to two-dimensional condensation. In the two-dimensional condensed state the molecules retain their rotations and inner vibrations. At sufficiently high temperatures and at sufficiently low degrees of coverage molecules of CH_4, C_2H_6, C_2H_4, (C_3H_6) and C_2H_2, when adsorbed on charcoal, show some degree of super-mobility. A.

541.183 : 536.75

7835. Entropy and mobility of adsorbed molecules. V. CO, CO_2 and CS_2 on charcoal. J. H. DE BOER AND S. KRUYER. *Proc. K. Ned. Akad. Wetensch. B*, **57**, 92–8 (*Jan.–Feb.*, 1954).

CO, CO_2 and CS_2, when adsorbed on charcoal at temperatures in the neighbourhood of room temperature, behave as two-dimensional gases. Adsorbed CO at temperatures higher than room temperature, is "super mobile," whilst at temperatures lower than 63°K its movements are strongly hindered. The adsorbed molecules of all three gases rotate freely. A.

541.183 : 537.364

Experimental study of surface potential analysis. *See Abstr.* 7460–3

541.183.1

7836. Applications of radiotracers to the study of surfaces. J. E. WILLARD. *J. phys. Chem.*, **57**, 129–34 (*Feb.*, 1953).

Discusses ways in which radiotracers can be useful as tools in the study of reactions of surfaces. Illustrations are taken from several types of investigations. New information is presented on the reaction of bromine vapour with glass, on a method for the determination of sticking coefficients of gaseous particles striking surfaces and on the reaction of unsaturated vapours of organic compounds with surfaces in evacuated systems. A.

541.183.1

7837. Radioactive monolayers: a new approach to surface research. D. E. BEISCHER. *J. phys. Chem.*, **57**, 134–8 (*Feb.*, 1954).

An investigation of the uses of monomolecular layers prepared by the method of Langmuir and Blodgett to bring a limited supply of a reagent in the form of a homogeneous monolayer of carbon-14 tagged stearic acid on the surface of different materials. The system is heated to a degree where chemical reaction of the coating material with the topmost layer of the surface takes place. The excess of the monolayer reagent is then removed and the distribution of the reaction product visualized in a radio-autograph of the surface. The extreme sensitivity of this method allows localization and measurement of small differences in the chemical activity of a surface. A.

541.183.1 : 539.27

7838. Field emission microscope and flash filament techniques for the study of structure and adsorption on metal surfaces. J. A. BECKER AND C. D. HARTMAN. *J. phys. Chem.*, **57**, 153–9 (*Feb.*, 1953).

With field emission electron microscopes one can see the structure of the surface of a single crystal at the tip of a metal "point." The magnification is about 10^6 and the resolution about 20×10^{-8} cm. At 2800°K, the surface of W point is hemispherical. Only the 110, 111 and 100 regions consist of small flat planes. In fields of 50 million volts/cm and at 1200°K these planes enlarge. The edges of the planes are seen to be in violent agitation. Hence surface atoms are mobile at temperatures above one-third of the melting point. Ba atoms show surface mobility at 400°K on the 110 and at 800°K on the 100 planes. With the flash filament technique one can measure the rate at which N_2 is adsorbed on a W ribbon at low pressures. After N_2 has been adsorbed for minutes at a low temperature, the ribbon is flashed at 2300°K. The sudden rise of pressure is recorded with an ion gauge and measures θ, the layers adsorbed. From a family of θ *v.* time curves one calculates s, the sticking probability. For $T = 300$°K, $s = 0{\cdot}55$ from $\theta = 0$ to $1{\cdot}0$. Then s decreases from $0{\cdot}55$ to about 4×10^{-4} for $\theta = 2{\cdot}0$. These data yield an activation energy for the conversion of a molecule to two adatoms of about 100 cal/mole for $\theta = 0$ to $1{\cdot}0$ and 5000 cal/mole at $\theta = 2{\cdot}0$. Other experiments yield 100 000 cal/mole for the heat of adsorption of 2 adatoms. The heat of adsorption of molecules is much smaller. A.

541.183.5 : 538.222

7839. The adsorption and the magnetic ortho-para conversion of hydrogen on diamagnetic solids. I. Some experiments in surface paramagnetism. Y. L. SANDLER. *J. phys. Chem.*, **58**, 54–7 (*Jan.*, 1954).

The rates of the magnetic ortho–para conversion of hydrogen adsorbed on some diamagnetic solids were determined and the true half-lives found by means of adsorption measurements. True half-lives of 1 to 6 min were found with $BaSO_4$ and 2 samples of TiO_2 at 90°K. The appearance of a strong blue colour in a sample of TiO_2 due to loss of oxygen on heating *in vacuo* and disappearance of the colour on contact with oxygen at room temperature is accompanied by changes in surface paramagnetism, as determined by the parahydrogen conversion. A method for estimating the number of extra electrons due to surface defects is indicated; for this, the true conversion rate found is compared with the true conversion rate in presence of measured amounts of molecular oxygen adsorbed on diamagnetic surfaces. The true half-life on a solid D_2O surface is found to be about 10 hr; this is shown to be the expected order of magnitude if compared with conversion rates of hydrogen, dissolved in diamagnetic liquids. A.

541.183.5 : 538.222

7840. The adsorption and ortho–para conversion of hydrogen on diamagnetic solids. II. The relative adsorbabilities of orthohydrogen and parahydrogen. Y. L. SANDLER. *J. phys. Chem.*, **58**, 58–61 (*Jan.*, 1954).

It is shown that orthohydrogen is more strongly adsorbed than parahydrogen when physically adsorbed on TiO_2 or charcoals. A separation factor of about $1{\cdot}6$ is observed with TiO_2 at -183°C. The effect of the preferential adsorption on the kinetics of the ortho–para conversion is demonstrated. It may be obscured by a lag in the establishment of the adsorption equilibrium. The separation effect is explained as being principally due to hindered rotation. A.

CHEMICAL STRUCTURE 541.2/.6

541.24 : 535.434

Correction for absorption and fluorescence in the determination of molecular weights by light scattering. *See Abstr.* 7346

541.51

7841. A vector representation of chemical affinities. C. A. Hollingsworth and R. L. Potter. Letter in *J. chem. Phys.*, **22**, 761–2 (*April*, 1954).

The vector spaces used are (i) a mole space of dimension equal to the number of chemical species, (ii) a 2-dimensional thermodynamic space, (iii) a total space, being the combination of (i) and (ii). The condition for an isoaffine reaction, in a closed system, is neatly expressed in terms of the reaction and the chemical potential vectors. J. JACOBS

541.57 : 539.132

Sulphur bonds. *See Abstr.* 7622

541.63

7842. A proton magnetic resonance study of the hydration of deoxyribonucleic acid. B. Jacobson, W. A. Anderson and J. T. Arnold. Letter in *Nature* [*London*] **173**, 772–3 (*April* 24, 1954).

The area of the narrow (3 mG wide) proton magnetic resonance signal of H_2O is markedly reduced in solutions of Na deoxyribonucleate (0·06 to 60% by weight) which attracts H_2O molecules to a large ice-like hydration shell for which the proton signal is so broad as to disappear. NaCl reduces the effect which is not shown by the less hydrated egg albumin or haemocyanin. D. H. WHIFFEN

541.68 : 539.13 : 534.22

Sound velocity and chemical constitution. *See Abstr.* 7197

LABORATORY APPARATUS 542.1/.7

542.2

7843. Making crystal spheres. W. L. Bond. Letter in *Rev. sci. Instrum.*, **25**, 401 (*April*, 1954).

A cup abrasive wheel is mounted on a shaft so as to be driven by a small motor at a nominal speed. An air stream blows the blanks in a direction opposite to the abrasive wheel motion. A cube or short cylinder can be ground approximately spherical in this machine and finished very smoothly and accurately by the method used by lapidaries where the ball is caught between a fixed and a moving tube and the abrasive is applied by a brush. With spheres larger than a millimetre the process is fast, easy and accurate. S. C. DUNN

542.48

7844. Vacuum evaporation of aluminium. R. L. Kelly and P. J. Rice. Letter in *Rev. sci. Instrum.*, **25**, 391 (*April*, 1954).

A tantalum insert for the alundum-coated tungsten wire crucibles used in the evaporation of aluminium, is described. This replaceable insert permits the crucible to be used several times. G. WITTENBERG

542.73

7845. A simple pump for circulating pure gas. J. A. Earl. Note in *Rev. sci. Instrum.*, **25**, 397–8 (*April*, 1954).

Electrical heating of the gas in a brass pump cylinder expels gas through a purifier to, e.g. an ionization chamber. On switching off, cooling draws in gas from the ionization chamber through a solenoid-opened valve; the purifier resistance acts in place of a second valve. A complete cycle (cam-operated) is $\sim$30 secs. Typical circulation: 150 cm^3/min, purifying 450 litres of A without contact with oil or other contaminant.

CHEMICAL PROCESSES 542.9

542.941 : 536.7

7846. Thermodynamics of the hydrogenation of benzene. G. J. Janz. Letter in *J. chem. Phys.*, **22**, 751–2 (*April*, 1954).

Re-examines, in the light of recent thermodynamic data, the calculations of equilibria in the systems $C_6H_6 \overset{H_2}{\rightleftharpoons} C_6H_8 \overset{H_2}{\rightleftharpoons} C_6H_{10} \overset{H_2}{\rightleftharpoons} C_6H_{12}$, and direct experimental measurements of the overall-reaction equilibrium. F. LACHMAN

542.943.5

7847. Oxidation of nitrogen by ozone to form nitrous oxide. P. Harteck and S. Dondes. *J. chem. Phys.*, **22**, 758 (*April*, 1954).

A small but experimentally detectable quantity (q) of N_2O is produced when a mixture of N_2 with O_2 containing 5% O_3 is passed through a furnace at 295°c. q corresponds to a conversion of about 10^{-4} O_3 into N_2O. The small amount of N_2 in cylinder O_2 produces a detectable amount of N_2O in an ozonizer. S. J. GREGG

CHEMICAL ANALYSIS 543/545

545.822

7848. A general infrared spectrophotometric technique for the determination of deuterium in organic compounds. N. R. Trenner, B. Arison and R. W. Walker. *Appl. Spectrosc.*, **7**, 166–71 (*Nov.*, 1953).

A method is described for the determination of deuterium in organic compounds through measurement of the water of combustion. The method allows the use of the isotope dilution techniques in assays not feasible by direct infrared spectrophotometry. This occurs because introduction of deuterium may not materially alter the spectrum. The absorbance of water containing heavy water was measured as a function of composition in a cell in which the temperature could be kept constant to within 0·1°c. The combustion and water-collecting apparatus and procedure is described in great detail. A. J. TAYLOR

CRYSTALLOGRAPHY 548

548.5

7849. Occurrence of preferred orientations on decomposition of KCl–NaCl mix-crystals. W. G. Burgers and G. W. Tichelaar. *Proc. K. Ned. Akad. Wetensch. B*, **57**, 73–8 (*Jan.–Feb.*, 1954).

As appeared from an X-ray investigation, the ageing of single crystals of supersaturated KCl–NaCl solid solutions gives rise to preferred orientations of the lattice of the equilibrium phases. Some of the diffraction patterns are described and the relation of the preferred orientation to the orientation of the parent single crystal is indicated. A.

548.5

7850. Cross section of pulled crystals. R. G. Pohl. *J. appl. Phys.*, **25**, 668–9 (*May*, 1954).

An equation for the radius of a crystal grown by the Czochralski technique is derived by considering the mechanical and thermal equilibrium at the liquid-solid interface. The results agree qualitatively with experimentally known functional dependencies. A.

548.5 : 537.311.33

7851. Recrystallization of germanium from indium solution. J. I. Pankove. *R.C.A. Rev.*, **15**, 75–85 (*March*, 1954).

Upon cooling a germanium-in-indium solution in contact with solid germanium, germanium from the supersaturated solution recrystallized on to the solid crystal in epitaxial fashion. The growth forms a group of separate [100] needles consisting of a stack of (111) plates, many of which are hollow. Although the outer portion of the recrystallized region may be rich in defects, there is a relatively perfect continuous recrystallized layer or overgrowth region adjacent to the *p–n* junction. This overgrowth region is a single crystal *p*-type semiconductor which continues the lattice of the *n*-type seed. The overgrowth is thinnest in the (100) direction. There is some indication that the alloy front, and hence the *p–n* junction, tend to be flattest in (111) planes. The *p–n* junction seems to coincide with the alloy front at least within the limits of the present experimental resolution. A.

548.57

7852. The markings in the cleavage surfaces of zinc single crystals. A. Deruyttere and G. B. Greenough. *Phil. Mag.*, **45**, 624–30 (*June*, 1954).

Zinc single crystals of various orientations were broken by applied tensile stresses at −196°C. The two faces of the cleavage fracture were examined and compared; in general they differed markedly. It was noted that the cleavage crack tends to propagate along the active slip direction, and that the distribution of the twins and kink bands is related to the region of the origin of the fracture and to the direction of crack propagation. The majority of the observations on the twins are entirely in accord with the theory of Bilby and Bullough (see following abstract), although more experimental work is necessary to clarify some points where there are discrepancies. In the case of the kink bands, however, there is little agreement between the observations and the theoretical results. A.

548.57

7853. The formation of twins by a moving crack. B. A. Bilby and R. Bullough. *Phil. Mag.*, **45**, 631–46 (*June*, 1954).

Expressions are derived for the elastic stresses round a long straight crack of constant form moving in an isotropic elastic medium under a general state of applied stress. These are used to examine the mechanical twinning to be expected on the cleavage surfaces of single crystals, on the assumption that this twinning is initiated by the high local stresses near the propagating fracture crack. It is assumed that the twin formation is controlled by the value of the local shear stress on the twinning plane resolved in the twinning direction. The theory is applied in detail to the twinning and certain other features of the deformation associated with the cleavage fracture of zinc single crystals. It provides a consistent explanation of some experimental observations (see preceding abstract). Applications of the analysis to other materials, and to other inhomogeneities causing high local stresses are also discussed. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

7854. Successive orientational transitions in crystals. T. J. Krieger and H. M. James. *J. chem. Phys.*, **22**, 796–814 (*May*, 1954).

An extended discussion is given of a crystal model showing successive "rotational" or orientational transitions. This model consists of an array of classical rotators with next-neighbour coupling, the potential energy of coupling being $E(\theta_{ij}) = AP_1(\cos\theta_{ij}) + BP_2(\cos\theta_{ij})$, where θ_{ij} is the angle between the molecular axes of symmetry. It is treated by both the internal field approximation (Bragg–Williams approximation) and Chang's modification of Bethe's method. The internal field approximation is applied in two ways, the first involving use of consistency relations, the second involving calculations of the thermodynamic potentials. The consistency relations are shown to be equivalent to the condition that the free energy be stationary, but not necessarily a minimum, with respect to variation of the orientational distribution of the molecules. Depending on the relative values of A and B, the model shows a single second-order transition, a single first-order transition, two first-order transitions, or a second-order transition followed by a first-order transition as T rises. The treatment by Chang's method is not as complete as that by the internal field method, but gives confidence that the latter method is sufficiently accurate to indicate correctly the general behaviour of the model. Transition temperatures are computed by both methods, latent heats and specific heats by the internal field method only. The relatively complex behaviour of the model can be understood in general terms. In particular,

when two transitions occur, the one at lower temperature marks a change from an ordered state in which molecular axes tend to be all parallel to a preferred direction ("ferromagnetic" case) or alternately parallel and antiparallel ("antiferromagnetic" case) to another ordered state in which parallel and antiparallel orientations are equally probable for each molecule; the second transition is to a state of complete long-range orientational disorder. There are suggestive similarities between the behaviour of this model and the observed properties of the hydrogen and deuterium halides. A.

548.7

7855. Note on the vibration spectrum of a crystal. R. E. PEIERLS. *Proc. Nat. Inst. Sci. India*, **20**, 121–6 (*Jan.–Feb.*, 1954).

A simple mathematical proof of the rule usually employed for obtaining the spectrum of normal frequencies of a crystal, namely that the distribution is the same as that of a hypothetical crystal satisfying the "cyclic boundary conditions." A. D. LE CLAIRE

548.7

7856. Elastic spectrum of zinc from the temperature scattering of X-rays. R. E. JOYNSON. *Phys. Rev.*, **94**, 351–5 (*May* 15, 1954).

The temperature diffuse scattering of X-rays from a single crystal of zinc has been measured at room temperature using a Geiger counter spectrometer and crystal monochromated Cu $K\alpha$ radiation. The theory of Born, together with Begbie's theory of lattice dynamics for a hexagonal crystal, was used in the interpretation. A method was developed to separate the contributions to intensity from the acoustical and optical bands. Frequency curves for the six modes of vibration propagating parallel to the b_3 axis, and for the six modes propagating parallel to the b_2 axis were obtained. Measurements were in agreement with theory for long wavelength acoustical modes, but for shorter wavelengths the first neighbour theory was not in agreement with the measurements. Approximate values for seven of the eight nearest neighbour force constants were obtained, and these values could be used for the calculation of an approximate frequency distribution curve. A.

548.7

7857. Empirical relation between the maxima of absorption bands of alkali halide crystals. H. SAUVENIER. *Bull. Soc. Roy. Sci. Liège*, **23**, 62–8 (*Feb.*, 1954) *In French.*

It is shown that the frequencies of these maxima (ν) and the lattice spacings (d) can, within the limits of experimental error, be related by the equation $\nu d^n = C$, where n and C are constant for a given halogen. Averages have been taken of measurements by different workers, discrepancies being as great as 20 mμ for the F-band of KCl. A. J. TAYLOR

548.7 : 537.122 : 539.11

The effective mass of electrons in crystals. *See Abstr.* 7603

548.7

7858. Dislocations in crystals. W. T. READ, JR. *New York: McGraw-Hill* (1953) 228 *pp.*

Review in *Science*, **119**, 551–2 (*April* 23, 1954). ". . . by concentrating on partial dislocations, crystal growth, and on the grain boundary energy is able to give a very thorough, lucid treatment of these fields."

548.7

7859. Extraneous ions in ionic crystals. P. BRAUER. *Z. Elektrochem.*, **57**, *No.* 8, 744–7 (1953) *In German.*

Assuming the existence of spherical, charged, polarizable ions of definite size (and with a definite energy of ionization), one can calculate the energy of an extraneous ion in an ionic crystal if this energy differs markedly from that of the lattice ion. The energy of formation of the single disturbance spots ["Störstellen"] can be also calculated. F. LACHMAN

548.7 : 535.41

7860. Interferometric observation of mosaic structure on the (111) face of a single crystal of germanium. A. R. VERMA. *Proc. Phys. Soc.* [*London*] *B*, **67**, 359–60 (*April*, 1954).

The crystal face was shown to be covered with a mosaic of hexagonal figures of varying sizes. The hexagons appeared to be depressions in the crystal surface of up to ~900 Å in depth. It is suggested that the mosaic boundaries are rows of dislocations, visible in this case without recourse to etching techniques. D. G. AVERY

548.7

7861. Constrictions and jogs in extended dislocations. A. N. STROH. *Proc. Phys. Soc.* [*London*] *B*, **67**, 427–36 (*May*, 1954).

A constriction (defined as a point at which the two partial dislocations are recombined) must be formed before an extended dislocation can climb. The energy required is found to be about 6 eV, but may be reduced in the presence of an applied stress. Constrictions are more easily formed in Cottrell–Lomer locked dislocations than in free dislocations; the climb of a locked dislocation is considered. The different types of jogs which may be formed in an extended dislocation are discussed. In an appendix a new derivation of the expression for the line tension of a dislocation is given. A.

548.7

7862. Theory of radiationless transitions of *F* centres. H. J. G. MEYER. Letter in *Physica*, **20**, 181–2 (*March*, 1954).

The complete Huang-Rhys model [Abstr. 3196 (1951)] is used to calculate the probability of radiationless transitions in F-centres. Numerical evaluation shows that the ratio of this probability to that for a radiative transition is already 30 at 20°K for KBr and larger for NaCl and KCl which then explains the negative experimental results of Klick [Abstr. 732 (1951)]. For KI and RbCl the ratio is unity a little above room temperature. G. F. J. GARLICK

548.7

7863. Restoration of *F* and V_1 centers following low-temperature bleaching. R. V. HESKETH AND E. E. SCHNEIDER. Letter in *Phys. Rev.*, **94**, 494 (*April* 15, 1954).

Warming a KCl crystal after irradiation by X-rays at 113°K results in an increase of F-band absorption with a peak at 180°K. On recooling from 300°K to 113°K and then rewarming the peak recurs. It is

suggested that the effect is due to temporary creation of *F*-centres and subsequent destruction by thermal bleaching. A similar but sharper peak occurs in the V_1-band during warming. Tentative explanations are given. G. F. J. GARLICK

548.7 : 532.614.2

7864. The surface energy of colloidal metals in ionic lattices. A. B. SCOTT. *Phil. Mag.*, **45**, 610–20 (*June*, 1954).

The energy of the interface between small particles of alkali metal and an alkali halide lattice has been calculated. The energy is sufficient to account for the observed heat of dissociation of the colloidal particles to form *F*-centres. An estimate of the size of the particles is provided. A.

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 7794–6

548.73 : 53

The growth of X-ray diffraction work in the United States. *See Abstr.* 7097

548.73

7865. Structure reports for 1945–1946. Volume 10. Edited by A. J. C. WILSON. *Utrecht: A. Oesthoek's Uitgevers* (*for International Union of Crystallography*) (1953), viii + 325 *pp.*

Review in *Proc. Phys. Soc.* [*London*] *A*, **67**, 483 (*May*, 1954).

548.73

7866. Nomenclature of X-ray lines. G. B. DEODHAR AND B. K. AGARWAL. *J. sci. industr. Res.*, **12 B**, 639–41 (*Dec.*, 1953).

The use of a rationalized nomenclature [Abstr. 7679 (1952)] is again urged, and Wilson's criticism of the proposed notation (in that abstract) is answered. It is pointed out that a transition producing an X-ray line is to be regarded as a change in the whole atom from a state having a vacancy in an inner shell to one having a vacancy in an outer shell, rather than merely a movement of one electron from an outer shell to an inner one. A. R. STOKES

548.732

7867. On the theory of X-ray small-angle scattering. Y. Y. LI AND R. SMOLUCHOWSKI. *Phys. Rev.*, **94**, 866–71 (*May* 15, 1954).

It is pointed out that a Fourier inversion of the intensity distribution of X-ray scattering, taking the small-angle scattering alone, gives the electron density function of the continuum approximation. The procedure of including only the central scattering is practicable, when none of the peaks of the lattice diffraction occurs at such a small angle that their scattered intensity overlaps the central scattering. A general discussion of the choice of the sign of the phase factor in the Fourier transformation and of its experimental consequences is given. The analysis is applied to scattering in a supersaturated Al–Ag alloy and to a discussion of some of the approximate formulae used in fitting experimental data. When the electron density function of the scattering centre has an odd symmetry with respect to one of the co-ordinate variables, conclusions can be drawn about the scattered intensity distribution without actually knowing the density function. The most interesting case of an odd symmetry is the edge dislocation. An experiment is suggested to reveal the pileup of dislocations as well as the aggregation of vacancies along the slip plane of a metal crystal deformed by a pure shear stress. A.

548.732 : 537.531 : 535.34

7868. Contribution to the study of the absorption of X-rays, by plane quartz crystals, near the Bragg angle. G. BARRÈRE. *C.R. Acad. Sci.* [*Paris*] **238**, 1494–6 (*April* 5, 1954) *In French.*

The absorption of X-rays is increased if a thin layer of the quartz is etched away. This is attributed to the removal of an imperfect layer. See Abstr. 4014 (1952). A. R. STOKES

548.733

7869. A counter tube differential method for determining the diffuse X-ray small-angle scattering of preparations. L. KAHOVEC AND H. RUCK. *Z. Elektrochem.*, **57**, *No.* 9, 859–62 (1953) *In German.*

A brief survey of known counter-tube set-ups for measuring small-angle X-ray scattering is followed by a description of a differential method enabling the diffuse small-angle scattering to be determined down to an angle value of 2 minutes of arc measure (equivalent to a resolving power of 3000 Å). F. LACHMAN

548.733

7870. A new method of taking small-angle X-ray photographs free from diaphragm scattering. O. KRATKY. *Z. Elektrochem.*, **58**, *No.* 1, 49–53 (1954) *In German.*

Describes a novel camera ("Rahmenkamera") characterized by the beam's being bounded by a deep slit, as used in cases of small-angle scattering. It is claimed that this camera enables the diaphragm scattering to be eliminated even for polychromatic radiation. The camera is simple in construction and operation. Test photographs taken with a very primitive camera have yielded a completely disturbance-free range up to a primary-ray limit corresponding to the Bragg value of 1000 Å. F. LACHMAN

548.733

7871. A split-image film comparator for X-ray diffraction powder patterns. J. T. QUAN. *Rev. sci. Instrum.*, **25**, 399–401 (*April*, 1954).

A mirror device is described which enables the lower half of one powder photograph and the upper half of another photograph to be viewed together. Several uses are given. A. R. STOKES

548.734

7872. A note on deformation stacking faults in hexagonal close-packed lattices. J. W. CHRISTIAN. *Acta cryst.*, **7**, 415–16 (*May*, 1954).

Formulae for the intensity distribution in reciprocal space, and for the integrated intensity and integral breadth of a diffraction maximum, are given for a h.c.-p. structure containing a random distribution of deformation faults. A.

548.734.2

7873. On the diffraction of X-rays by a twisted crystal lattice. S. S. HSU. Letter in *J. appl. Phys.*, **25**, 541–2 (*April*, 1954).

Striated Laue spots were obtained from a twisted crystal by putting a grid of parallel wires in front of

the X-ray source; this is compared with the use of a Soller slit by Cullity and Julien [Abstr. 5780 (1953)].

A. R. STOKES

548.734.3

7874. The question of the accurate determination of crystal lattice constants from X-ray powder photographs. B. Ya. Pines and N. V. Kaluzhinova. *Zh. tekh. Fiz.*, **24**, *No.* 2, 320–5 (1954) *In Russian.*

To illustrate the elimination of errors from lattice spacing measurements the cell size of tungsten was determined giving $a = 3{\cdot}1589_9$ kX with an r.m.s. error of 10^{-4} kX [temperature not specified]. The specimen was apparently stationary on the axis of a 56·2 mm dia. powder camera. Cu radiation from a fine-focus tube was used; with a 0·1 mm dia. specimen the $K\alpha$ doublet was resolved for the 200 line. Uniform film shrinkage and uncertainties of film diameter were removed by the use of the asymmetric film position and eccentricity errors by taking a second photograph with the specimen turned through 180°. Displacements of lines due to absorption were allowed for by using specimens of five different diameters and extrapolating to zero diameter. A. L. MACKAY

548.735

7875. The statistical method of determining the signs of the structure amplitudes. A. I. Kitaĭgorodskiĭ. Letter in *Zh. eksper. teor. Fiz.*, **24**, *No.* 6, 747–8 (1953) *In Russian.*

The relationship (sign F_{hkl}) (sign $F_{h'k'l'}$) = (sign $F_{h+h',k+k'l+l'}$) is deduced and an expression for the limits of its validity is derived. If $x = \hat{F}_{hkl} \cdot \hat{F}_{h'k'l'} \cdot \hat{F}_{h+h',k+k',l+l'}$ and $g = 2[(\overline{x^2}/\bar{x}^2) - 1]^{-1}$ then W, the probability that x is positive, is given by $1/W = 1 + \exp(-gx/\bar{x})$. The probability that the sign relationship is true is greater when $\overline{x^2}/\bar{x}^2$ is small, the latter term being a minimum when there are heavy atoms in the cell. The signs of strong reflections are almost certain; i.e. when $|x|$ is large. In the least favourable case of identical atoms the lowest probability for 25 atoms is 85% and for 100 atoms 70%. A. L. MACKAY

548.735

7876. Probability distributions for atomic coordinates. J. Karle and H. Hauptman. *Acta cryst.*, **7**, 375–6 (*April*, 1954).

A complicated general expression is derived for the probability that a structure will have given atomic coordinates on the basis of a given set of structure amplitudes. A. R. STOKES

548.735

7877. Divisors for converting $\sin^2\theta$ for a standard wavelength. R. B. Russell. *Acta cryst.*, **7**, 454–5 (*May*, 1954).

548.735

7878. Cylindrically symmetrical distribution functions and their application in the structure investigation of cellulose. N. Norman. *Acta cryst.*, **7**, 462–3 (*May*, 1954).

548.736.1

7879. Effect of grain size on the crystal structure of cobalt. E. A. Owen and D. M. Jones. *Proc. Phys. Soc.* [*London*] *B*, **67**, 456–66 (*June*, 1954).

Gives an account of measurements made on the lattice parameter of cobalt when the material contained crystal grains of different sizes as found in fine dust, filings and annealed solid gold. The stable structure of cobalt was found to depend upon the grain size: between room temperature and about 450°C when the grain size is very small, as in cobalt sponge, the stable structure is face-centred cubic; when the grain size is larger, as in a solid rod, the stable structure is close-packed hexagonal; when there is a range of grain size, as in fine filings a mixture of these two structures is observed. At temperatures above 450°C cobalt sponge is still face-centred cubic, and the filings and rod also now show face-centred cubic structure with the same lattice parameter (3·5370 kX at 18°C). The lattice constants of the hexagonal close-packed structure at 18°C are: $a = 2{\cdot}5003$ kX, $c/a = 1{\cdot}632_2$. Different results were obtained according as the material was maintained and examined at elevated temperature or was quenched from elevated temperature and examined at room temperature. All specimens of cobalt, whatever the grain size, annealed at about 1000°C and quenched showed a mixture of the two structures although with cobalt sponge the amount of the hexagonal structure was very small compared with the amount of the cubic structure. The main results fit the theory of the imperfect hexagonal structure put forward by Edwards and Lipson (1943). The thermal expansion of cobalt sponge is represented by a smooth curve. It shows no transformation such as is found at about 450°C with material in solid form. No other high-temperature transformation was observed. A.

548.736.1

7880. Structure of Gd, Dy, and Er at low temperatures. J. R. Banister, S. Legvold and F. H. Spedding. *Phys. Rev.*, **94**, 1140–2 (*June* 1, 1954).

The crystal structures have been determined over a wide temperature range. The metals are hexagonal close-packed and the a_0 unit axis contracts nearly linearly with decreasing temperature, whereas the c_0 unit axis exhibits an abnormal expansion with decreasing temperature below magnetic transformations of the metals. The c_0 behaviour is believed to be associated with the magnetic properties of the metals. A.

548.736.1 : 537.312.62

7881. The crystal structure and superconductivity of lanthanum. W. T. Ziegler, R. A. Young and A. L. Floyd, Jr. *J. Amer. Chem. Soc.*, **75**, 1215–21 (*March* 5, 1954).

The crystal structure of lanthanum has been studied by powder X-ray diffraction techniques at room temperature and the existence of the hexagonal close-packed (h.c.p.) and face-centred cubic (f.c.c.) modifications confirmed. The rate of interconversion of these crystal forms has been found to be slow. However, it has been shown that the f.c.c. modification can readily be converted to the h.c.p. structure at room temperature by severe deformation such as results when filings are produced from a massive specimen. The crystal structure of lanthanum filings in the h.c.p. form was not affected by cooling to liquid helium temperatures; the same result (with one possible exception) was noted with filings having the f.c.c.

structure. Six different samples of lanthanum have been examined for superconductivity by a magnetic method. It was found that bulk specimens cut from the six samples in the as-received state each exhibited a transition into superconductivity in the range 3·1° to 5·45°K. Heat treatment for four days at 350° raised the transition temperatures somewhat. The three purest samples all gave a transition temperature of very nearly 5·4°K. From X-ray diffraction studies made of the bulk specimens, together with studies made on filings, it was concluded that both the f.c.c. and h.c.p. modifications of lanthanum are superconductors, the f.c.c. modification having a transition temperature near 5·4 K, while the h.c.p. modification (in a strained state) has a transition temperature of 3·9°K or greater. A.

548.736.3

7882. An X-ray crystallographic investigation of alloys in the system Al–Pd. Yu. P. Simanov. *Zh. fiz. Khim.*, **27**, *No.* 10, 1503–9 (1953) *In Russian.*

The Al–Pd system was found to be similar to that of Ni–Al. A compound Al_3Pd was identified and found to be orthorhombic with $a = 7·071 \pm 0·005$, $b = 7·516 \pm 0·005$, and $c = 5·077 \pm 0·005$ kX and space group *Pnnm* or *Pnn*2. More accurate values, namely $a = 4·2095 \pm 0·0015$ and $c = 5·156 \pm 0·002$ kX, were found for the dimensions of the hexagonal phase Al_3Pd_2 (probable space group $C\bar{3}m$ by analogy with Al_3Ni_2). The cell side of the cubic high-temperature form of AlPd was found to be $3·043 \pm 0·0008$ kX and a further low-temperature form with this composition was discovered which was hexagonal, having dimensions $a = 3·956 \pm 0·002$ and $c = 5·599 \pm 0·005$ kX and space group *C*6/*mcc* or *C*6*cc*. A. L. MACKAY

548.736.3

7883. The crystal structure of $I_2Cl_6(ICl_3)$. K. H. Boswijk and E. H. Wiebenga. *Acta. cryst.*, **7**, 417–23 (*April*, 1954).

I_2Cl_6 crystallizes in complexly twinned triclinic crystals; space group $P\bar{1}$, one I_2Cl_6 per unit cell. The crystal structure was determined by the use of three-dimensional Patterson and Fourier syntheses. The final value of the disagreement factor R was 0·12. The bond lengths are subject to an uncertainty of 0·02 Å and in addition to this to a standard deviation of 0·01 Å. The structure consists of planar molecules with negligible deviations from the point group symmetry *mmm*. Each iodine atom is surrounded by two chlorine atoms at a distance of 2·41 and 2·43 Å and by two others at 2·72 and 2·77 Å. A discussion of the twinning and of the atomic distances is given. A.

548.736.3

7884. The effect on metal–metal bonds of increased concentration of hydrogen in hafnium dihydride. S. S. Sidhu. *Acta cryst.*, **7**, 447–9 (*May*, 1954).

A tetragonal unit cell of hafnium dihydride is formed at a composition of $HfH_{1·87}$. Each metal atom has 12 Hf atoms as its neighbours, 8 at a distance $3·289 \pm 0·002$ Å and 4 at $3·461 \pm 0·002$ Å; they constitute short and long metal–metal bonds respectively. As the concentration of hydrogen atom is increased, the dihydride structure exhibits anisotropic changes; a_0 increases and c_0 decreases. It is shown that the anistropy arises from the additional metal–gas bonding, which strengthens the short and weakens the long metal–metal bonds. A.

548.736.3

7885. The intermediate phase Zr_2Si. P. Pietrokowsky. *Acta cryst.*, **7**, 435–8 (*May*, 1954).

548.736.3

7886. The crystal structure of rhodium silicide, RhSi. S. Geller and E. A. Wood. *Acta cryst.*, **7**, 441–3 (*May*, 1954).

548.736.3

7887. The crystal structure of TiU_2. A. G. Knapton. *Acta cryst.*, **7**, 457–8 (*May*, 1954).

548.736.3

7888. The crystal structures of YF_3 and related compounds. A. Zalkin and D. H. Templeton. *J. Amer. Chem. Soc.*, **75**, 2453–8 (*May* 20, 1953).

The crystal structure of YF_3 has been determined from single crystal X-ray diffraction data. It is orthorhombic, space group *Pnma*, with $a = 6·353$, $b = 6·850$, $c = 4·393$, $Z = 4$ and $D_x = 5·069$. The atomic parameters are similar to those in cementite, Fe_3C, but the co-ordination numbers are different. The unit cells have been determined for the compounds SmF_3, EuF_3, GdF_3, TbF_3, DyF_3, HoF_3, ErF_3, TmF_3, YbF_3 and LuF_3 which are isostructural with YF_3. SmF_3, EuF_3, HoF_3 and TmF_3 were also observed with hexagonal structures like that of LaF_3. Three cubic phases are tentatively identified as $NH_4Ho_3F_{10}$, $NH_4Er_3F_{10}$ and $NH_4Tm_3F_{10}$ and a structure is proposed for these and for the cubic "YF_3" of Nowacki. HoOF is cubic with a disordered CaF_2 type structure. A.

548.736.5

7889. An investigation of calcium diborate, $CaB_2O_4 . 6H_2O$. A. F. Ievin'sh and Ya. K. Ozol. *Zh. fiz. Khim.*, **27**, *No.* 10, 1510–15 (1953) *In Russian.*

The dimensions of the monoclinic cell of $CaB_2O_4 . 6H_2O$ were found to be $a = 7·9836 \pm 0·0001$, $b = 6·7124 \pm 0·0001$, $c = 7·9532 \pm 0·0002$ kX and $\beta = 103·798° \pm 0·001°$. The density (all measurements at 25°c) was found to be 1·870 g/cm³, giving $Z_{calc.} = 2·05$. Wavelengths used were Cu $K_{\alpha 1,2}$ 1·537 395 and 1·541 232, and Fe $K_{\alpha 1,2}$ 1·932 076 and 1·936 012. A. L. MACKAY

548.736.5

7890. Cation distributions in mixed ferrites. J. S. Smart. *Phys. Rev.*, **94**, 847–50 (*May* 15, 1954).

In materials with the spinel structure, such as the ferrites, the cations are located on two different types of crystallographic sites. Expressions are derived for the equilibrium distribution of cations in mixed ferrites, which contain three different types of cations. It is suggested that the cation distributions in such ferrites may be determined from the experimental values of magnetic moment and g factor. The method is applied to the nickel ferrite-aluminate series; the results agree reasonably well with X-ray diffraction data. A.

548.737

7891. X-ray diffraction by imidazole methaemoglobin. W. L. Bragg and E. R. Howells. *Acta cryst.*, **7**, 409–11 (*May*, 1954).

The precession X-ray photographs appear to indicate a structure with orthorhombic symmetry, but it is actually only "statistically orthorhombic." The sheets of molecules in the *c* planes have a definite structure identical with that in monoclinic horse methaemoglobin. Successive sheets, however, are stacked together with a displacement in the *a* direction which is definite in amount, but of plus or minus sign in a completely random way. The diffraction picture shows an interesting sequence of diffuse and sharp layer lines and also relationships between the intensities of its reflections and those of the monoclinic form. A.

548.737

7892. X-ray diffraction by a layer structure containing random displacements. W. Cochran and E. R. Howells. *Acta cryst.*, **7**, 412–15 (*May*, 1954).

The diffraction pattern to be expected from crystals of imidazole methaemoglobin, which have an unusual type of fault structure, is calculated and found to agree well with the experimental observations. A.

548.737

7893. The crystal structure of methyl chloride at −125°. R. D. Burbank. *J. Amer. Chem. Soc.*, **75**, 1211–14 (*March* 5, 1953).

This has been investigated by X-ray diffraction. The arrangement of the molecules is equivalent to that in the chlorine structure if the methyl groups are replaced by chlorine atoms. The chlorine–carbon bond distance is 1·805 Å. Several possible orientations of the methyl group have been considered and an orientation in which the intermolecular chlorine–hydrogen distances are all 3 Å or more is in best agreement with the X-ray data. A.

548.737

7894. A statistical structure for crystalline rubber. S. C. Nyburg. *Acta cryst.*, **7**, 385–92 (*May*, 1954).

548.737

7895. The crystal structure of tetraiodoethylene. T. L. Khotsyanova, A. I. Kitaĭgorodskiĭ and Yu. T. Struchkov. *Zh. fiz. Khim.*, **27**, *No.* 9, 1330–43 (1953) *In Russian.*

C_2I_4 crystals are monoclinic, with space group $P2_1/c$ and dimensions $a = 15{\cdot}10 \pm 0{\cdot}05$, $b = 4{\cdot}45 \pm 0{\cdot}02$ and $c = 13{\cdot}00 \pm 0{\cdot}04$ Å; $\beta = 109° \pm 1°$; $Z = 4$ and $\rho_{obs.} = 3{\cdot}98$ g/cm³. The *x* and *z* co-ordinates of the I atoms were found from a Patterson projection and the *y* co-ordinates from line summations and an algebraic method. 1078 reflections were used in the final syntheses. The four I atoms of each molecule form a square of side $3{\cdot}64 \pm 0{\cdot}01$ Å. The I–C–I bond-angle is estimated at 115° 30′. The departures of the I atoms from sphericity are discussed. The effective radius is increased to 2·25 Å perpendicular to the molecular plane and reduced to 1·85 Å along the diagonals. A. L. MACKAY

548.737 : 536.413.2

7896. Low-temperature studies of the structures of aromatic compounds. II. The anisotropy of the thermal expansion of anthracene. V. M. Kozhin and A. I. Kitaĭgorodskiĭ. *Zh. fiz. Khim.*, **27**, *No.* 11, 1676–81 (1953) *In Russian.*

For Pt I, see Abstr. 8798 (1953). By X-ray crystallographic methods the mean thermal expansion coefficients over the range −195° to 20° were found to be $\alpha_{11} = (111{\cdot}7 \pm 3{\cdot}3) \times 10^{-6}$; $\alpha_{22} = (13{\cdot}4 \pm 0{\cdot}4) \times 10^{-6}$; $\alpha_{33} = (20{\cdot}3 \pm 0{\cdot}6) \times 10^{-6}$. The direction of α_{22} coincides with *b* and the direction of α_{11} makes an angle of 51° with *a*. A. L. MACKAY

548.737 : 539.133

7897. Molecular structure of fluorene. D. M. Burns and J. Iball. Letter in *Nature* [*London*] **173**, 635 (*April* 3, 1954).

By means of two-dimension Fourier syntheses the crystal structure of fluorene has been detailed. The crystals are orthorhombic with $a = 8{\cdot}49$, $b = 5{\cdot}72$, $c = 18{\cdot}97$ Å; space group *Pnam*; 4 molecules per unit cell. The molecule possesses a plane of symmetry which coincides with the crystal symmetry plane parallel to (001). The carbon atoms lie on a plane ($y = 1{\cdot}4375x + 11{\cdot}0947$) with a maximum deviation of 0·03 Å. A diagram gives the bond lengths and bond angles of the molecule. J. IBALL

548.74

7898. The nature of the specular reflexion of electrons from a crystal surface. S. Miyake, K. Kohra and M. Takagi. *Acta cryst.*, **7**, 393–401 (*May*, 1954).

In electron diffraction patterns from smooth cleavage surfaces of single crystals, a sharp reflection having a specular relation to the incident beam appears for all glancing angles of the incident electrons. Its intensity is especially enhanced when the reflection happens to fall on a Kikuchi line. This reflection has formerly been considered as a two-dimensional diffraction effect caused by the high absorption of electrons within solids. The present authors propose an interpretation according to the dynamical theory of diffraction, neglecting absorption; they take account of the fact that enhancement of the specular reflection occurs when a Bragg reflection in a side direction takes place inside the crystal. It is shown that the regular total reflection of the incident electrons by the surface may take place even when the Bragg condition is not satisfied for the lattice plane parallel to the surface, and the phenomenon of enhancement can be explained as the result of Bragg reflection on a side plane. The total reflection of the interior wave at the surface plays an important role in producing enhancement. It is noted that the proper choice of the wave points in reciprocal space is essential in this problem. The influence of the weak constituents of the internal wave field on the intensity of the specular reflection is also discussed. A.

548.74

7899. Atomic scattering amplitudes for electron diffraction. J. A. Ibers and J. A. Hoerni. *Acta cryst.*, **7**, 405–8 (*May*, 1954).

Scattering amplitudes for 40 keV electrons have been computed from the partial waves scattering theory for selected atoms and for scattering angles between 0° and 28°. The Thomas–Fermi potential was used in these calculations; in some instances

Hartree potentials were also used and the results from the different potentials are compared. A.

548.74

7900. Thermal vibrations of crystals and neutron diffraction. M. MOSHINSKY. *Rev. Mexicana Fis.*, **3**, 1–23 (*Jan.*, 1954) *In Spanish.*

The method used could be called semi-classical because, on the one hand, the state of the neutron is described by a wave function satisfying a Schrödinger equation, and on the other, the vibrations of the crystal lattice are described from a classical standpoint. The interaction between neutron and vibrating nucleus is given in terms of a δ function, that depends on the instantaneous position of the nucleus, and therefore, on the time. The time-dependent Schrödinger equation is solved by means of a Laplace transform, and the elastic and inelastic differential scattering cross-sections are obtained. These cross-sections are compared with those obtained by Weinstock, for the scattering of neutrons by crystals in thermal vibration. A.

548.74 : 539.185

7901. Neutron diffraction determination of the crystal structure of ammonium bromide in four phases. H. A. LEVY AND S. W. PETERSON. *J. Amer. Chem. Soc.*, **75**, 1536–42 (*April* 5, 1953).

The structures of ND_4Br in four phases have been studied. Low temperature cubic ND_4Br contains ordered, parallel ammonium ions. In tetragonal ND_4Br, adjacent strings of ammonium ions are antiparallel, and bromide ions are displaced toward a square array of near hydrogen atoms. Room temperature ND_4Br contains ammonium ions at random in two orientations. High temperature cubic ND_4Br appears to contain ammonium ions in which one, two or three hydrogen atoms make minimal approaches to bromide neighbours; further specification cannot be given from present data. In all structures there appears to be a significant attraction between D and Br. Information about thermal motions in the crystal is derived, including evidence for rotatory oscillation of the ammonium ions. The length of the N–D link is $1{\cdot}03 \pm 0{\cdot}02$ Å. A.

GEOPHYSICS 55

550.342

7902. On a new method for the registration of microseisms. P. BERNARD. *C.R. Acad. Sci.* [*Paris*] **238**, 1528–30 (*April* 5, 1954) *In French.*

Reproductions are given of the first records obtained with a device developed at the Laboratoire National de Radioélectricité by F. Carbenay [*Ann. Télécomm.*, **1**, *No.* 7, p. 128 (1946)]. Bernard's arrangement of this instrument in a vertical seismograph is described in some detail, in particular in its application to the measurement of microseisms, having periods between 4 and 8 seconds, and variable amplitudes. It is emphasized how these microseismic records can be used successfully in meteorological forecasts, particularly in connection with surf and heavy breakers.

A. BEER

550.37

7903. Short period fluctuations in the electromagnetic field of the earth. V. A. TROITSKAYA. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 2, 241–4 (1953) *In Russian.*

A particular type of fluctuation of the electric field unaccompanied by changes in the magnetic field has been studied. Short trains of oscillations occur with a maximum frequency at about 19 hr universal time. It is suggested that these are caused by particles emitted by the sun and focused by the earth's magnetic field. J. M. HOUGH

550.382

7904. Rock-magnetism. T. NAGATA. *Tokyo: Maruzen and Co.* (1953) viii + 232 *pp.*

Review in *Nature* [*London*] **173**, 840–1 (*May* 8, 1954).

550.382

7905. The remanent magnetism of some sedimentary rocks in Britain. J. A. CLEGG, M. ALMOND AND P. H. S. STUBBS. *Phil. Mag.*, **45**, 583–98 (*June*, 1954).

Describes a survey which was carried out to measure the natural remanent magnetism of Triassic sediments in England. Rocks from nine separate sites distributed over a wide area were found to have consistent polarizations, being magnetized in an approximately N E–S W direction with dips significantly less than that of the present earth's field. Similar results were obtained for sediments of the Carboniferous and Old Red Sandstone periods taken from two other sites. Approximately half of the specimens showed reverse polarization. Tests were also made to measure the magnetic stability of the rocks. The possible implications of the results are discussed. A.

550.384.4

7906. The lunar diurnal variations of the earth's magnetic field for all elements at Amberley, N.Z., based on five years' observations. J. M. BULLEN AND C. H. CUMMACK. *New Zealand J. Sci. Technol. B*, **35**, 371–7 (*March*, 1954).

The analysis of five years' records for the lunar diurnal variation at Amberley, New Zealand, is described. Chapman's phase law is assumed, and from this the probable error is computed. It is found that only the second harmonic of the variation may be regarded as reliable. The variation in the vertical component is much larger than that computed for northern hemisphere stations of approximately corresponding geographic and geomagnetic co-ordinates.

A.

550.42 : 539.16.08

7907. Thorium determination in deep-sea sediments. E. PICCIOTTO AND S. WILGAIN. Letter in *Nature* [*London*] **173**, 632–3 (*April* 3, 1954).

A photographic method is described for determining the Th^{232} concentration in sedimentary clays in the presence of other Th isotopes (Io, Rd–Ac and Rd–Th) by analysis of the single and 5-branched

stars [see also Abstr. 5795 (1953)]. In samples of red clay from the Pacific Ocean this concentration (5×10^{-6} gm Th/gm clay) is approximately constant. A method of dating these sediments from the Io–Th ratio is suggested. M. A. GRACE

ATMOSPHERE . METEOROLOGY 551.5

551.510.535

7908. A statistical study on the minimum frequency in h'–f curve for the E region of the ionosphere. H. KAMIYAMA. *Rep. Ionosphere Res. Japan*, **5**, *No.* 1, 13–24 (1951).

The study concerns the diurnal and seasonal variation and its relation to the sunspot number. The diurnal variation suggests that there exists an absorbing layer which is ionized by the solar radiation, in a lower region than the E layer. The seasonal variation indicates that the seasonal change of the temperature may occur in the middle atmosphere. Considering the relation to the sunspot number, the electron density in the D layer is estimated to be $1 \cdot 5 \times 10^4/\text{cm}^3$. A.

551.510.535

7909. On world-wide distributions of f_0F2. Y. AONO. *Rep. Ionosphere Res. Japan*, **6**, 69–78 (*June*, 1952).

World-wide distributions rotate around the earth with the sun, changing themselves in a regular way. Peculiar distributions are found in the Far East at noon. World-wide distribution of the difference of f_0F2 from its monthly median value is unexpectedly stable for a long time. In magnetic storms, the value of f_0F2 begins to decrease from both poles at night and fluctuates on a world-wide scale with a cycle of 2 or 3 hours. A.

551.510.535

7910. Some characteristics of ionospheric storms. T. OBAYASHI. *Rep. Ionosphere Res. Japan*, **6**, 79–84 (*June*, 1952).

The author has investigated the average storm variation and the occurrence-frequency of ionospheric turbulence by analysing quantitatively the data concerning the disturbance in the $F2$ region. The variations in f_0F2 and $h'F2$ during an ionospheric storm can be regarded as composed of two modes, i.e. the storm-time variation and the disturbance diurnal variation, the former representing the effects of the primary disturbance and the latter the influence of time of day and season. Accordingly, individual storms will have different aspects of their development according to the local times at which they occur. The occurrence-frequency of disturbances in the $F2$ region seems to be closely related to the normal height of the $F2$ layer. This may possibly be explained as follows: During the daytime in winter, when the F2 layer is normally situated in lower regions, disturbances are usually unable to reach these levels, and they are rarely observed. On the contrary, when the normal height is higher, as in summer, the layer can no longer be free from disturbance and is more susceptive to turbulence. A.

551.510.535

7911. The evaluation of ionospheric observations. G. GRAWERT AND H. LASSEN. *Z. angew. Phys.*, **6**, *No.* 3, 136–43 (1954) *In German.*

A review of the different methods of determining true height and electron concentration in a layer from the observed apparent height-frequency curves. The effect of two separate conducting layers and the earth's magnetic field are also considered. J. M. HOUGH

551.510.535 : 523.165

7912. A radio astronomical investigation of drift movements in the upper atmosphere. A. MAXWELL AND M. DAGG. *Phil. Mag.*, **45**, 551–69 (*June*, 1954).

The metre wavelength emission from the radio stars is diffracted by irregularities in the electron density of the ionosphere, which occur mainly at night at a height of approximately 400 km. Fading records taken with three receiving equipments, triangularly sited, show systematic time displacements, and these are attributed to a steady translational movement of the diffracting screen. The motion is normally of the order of 50–300 m/sec, is generally transverse to the magnetic lines of force and often remains constant over periods of many hours. During the first half of the night the prevailing direction is towards the West, at approximately 01 hr there is often a reversal, normally effected within a period of 30 min, and thereafter the motions are predominantly towards the East. The effective wavelength of the ionospheric irregularities remains appreciably constant over a velocity range of 20 : 1, so that the magnitude of the drift velocity may be estimated from a count of the fading rate. By observing the Cygnus source when it is low on the northern horizon it is possible to determine the F-region drift velocities in the auroral zone; these are about 400 m/sec, that is, twice as fast as the F-region motions at temperate latitudes. Investigation of the drift motions at points separated by 800 km suggests that the drift speeds and directions are the same over wide areas, and experiments made in co-operation with members of the Cavendish Laboratory, Cambridge, over a 200 km base line support this. Observations of F-region motions made elsewhere, with different techniques, are in good agreement with the present results. A.

551.510.535 : 550.384

7913. A relation between $F2$-layer disturbance and geomagnetic condition. N. FUKUSHIMA AND T. HAYASI. *Rep. Ionosphere Res. Japan*, **6**, 133–6 (*Sept.*, 1952).

The daily mean value of the electron density of the $F2$ layer varies with the daily geomagnetic condition. It appears that the electron density decreases in local summer and increases in local winter in the middle latitude regions of the northern and southern hemispheres. This systematic difference in the way of appearance of $F2$-layer disturbance with season may be due to the seasonal difference in the average values of h_p. A.

551.510.535 : 550.385

7914. Characteristics of ionospheric disturbances during severe magnetic storms. K. MIYA AND N. WAKAI. *Rep. Ionosphere Res. Japan*, **6**, 137–46 (*Sept.*, 1952).

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 7586–7

551.551

7915. Eddy diffusion of momentum, water vapour, and heat near the ground. N. E. RIDER. *Phil. Trans A*, **246**, *No.* 918, 481–501 (1954).

Measurements were made of the vertical profiles of wind speed, temperature and humidity, and of the rate of evaporation and the aerodynamic drag of the surface. Measurement of the heat-balance components was also attempted. On any one occasion it was not generally possible to observe all the desired quantities. It is found that the wind speed and temperature profiles always have the same form, and that this form is shared on the majority of occasions by the humidity profile. The profiles depart from the logarithmic form found in adiabatic conditions in the manner suggested by Deacon. In near adiabatic conditions the established laboratory law relating the surface drag to the fluid velocity over a rough surface in turbulent flow hold and a value is deduced for von Kármán's constant. In conditions other than adiabatic the explicit wind profile law suggested by Deacon holds in unstable but not in stable conditions. In the latter conditions equations proposed by Rossby and Montgomery and by Holtzman represent the observations with reasonable precision. The friction coefficient of the surface is found to be independent of wind speed but to increase in value in unstable conditions. It is found that the diffusivities for momentum and vapour are identical over the range of stability experienced. The magnitude of the diffusivity for heat often appears to be approximately the same as that for momentum or vapour, but exceptions occur when it is much larger than the other two. The exceptions do not appear to be related to stability. A.

551.557

7916. Systematic wind measurements at altitudes of 80–100 km using radio echoes from meteor trails. J. S. GREENHOW. *Phil. Mag.*, **45**, 471–90 (*May*, 1954).

Wind drifts of ionized meteor trails cause small changes in range of the radio echoes, and these are measured using a coherent pulse Doppler technique. The method is able to resolve mean hourly wind speeds and directions on any day. Observations during September and October, 1953, have shown that both semi-diurnal and diurnal wind components exist, corresponding to clockwise rotations of the wind vectors. The amplitudes and phases of these components are variable. There is also a prevailing wind which blows towards the east in September, and towards the west in October. The presence of a positive wind gradient of approximately $2{\cdot}7\ \text{msec}^{-1}\ \text{km}^{-1}$ between altitudes of 78 and 98 km has also been established. Large irregularities in the wind have been observed, and although at times the short period variation in wind velocity is as low as 25%, at other times variations of 360° in direction, and several hundred per cent in speed are observed over intervals of a few minutes. A.

551.574.1

7917. Thermodynamic study of saturation pressure with application to a droplet in suspension in the atmosphere. L. DUFOUR AND R. DEFAY. *Publ. Inst. Roy. Météorol. Belgique*, *No.* 9, 20 *pp.* (1953) *In French.*

General and approximate formulae are obtained for the saturation vapour pressure of water over a small drop having a mixed condensation nucleus, and for the special cases when the nucleus is composed solely of a soluble or insoluble substance. The insoluble substance does not affect the saturation vapour pressure. Numerical values are tabulated, for small and large nuclei of NaCl, of the ratio of the saturation vapour pressures for the small drop and for pure water as a function of the drop radius. The generalized results show the conditions under which the approximate equations can be used. The classical formula is inadequate because it does not allow for the drop being an electrolyte. R. S. READ

551.577.1

7918. The dimensions of raindrops. N. S. SHISHKIN. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 2, 171–4 (1953) *In Russian.*

A theoretical study of the way in which drop size depends upon the combination of condensation, coagulation, gravitation and upward air velocity.

J. M. HOUGH

551.578.4

7919. On the growth of snow flake and graupel. C. MAGONO. *Sci. Rep. Yokohama Nat. Univ. I*, *No.* 2, 18–40 (*March*, 1953).

Investigations on the growth of snow flakes and graupel (soft hail) were made at Hokkaido and Mt. Tokachi. It is considered that snow flakes grow by collision with slower falling snow crystals and not by collision between snow flakes or separate snow crystals. Photographs illustrate this growth. Estimates for the rate of growth of snow flakes were checked against theory. The principal mechanisms in the formation of rain drops are the aggregation of snow crystals to form snow flakes and the collision of supercooled cloud particles with soft hail. The conical shape and growth of soft hail are examined.

R. S. READ

551.593.9

7920. A photometric study of the blue region of the light of the night sky. D. BARBIER. *Ann. Astrophys.*, **17**, *No.* 2, 97–103 (1954) *In French.*

Spectrophotometric observations of the night-sky light at the Observatory of Haute-Provence, 1952–53, using methods analogous to those previously described in a study of the u.v. spectrum of the night sky [Abstr. 7360 (1953)] yield the following new results. The height of emission is very uncertain because of the high relative intensity of extra-terrestrial (starlight) radiation in the blue region of the night-sky spectrum, but it is ~200 km. Both diurnal and annual fluctuations of intensity in this region are fully comparable with those of the Herzberg bands, the forbidden [O I] line at 5577 Å, and the continuous spectrum.

D. R. BARBER

551.593.9 : 535.338.4–31

7921. The rotational structure of the ultraviolet bands of the night sky. J. W. CHAMBERLAIN. *C.R. Acad. Sci.* [*Paris*] **238**, 1329–31 (*March* 22, 1954) *In French.*

This structure has been well resolved in a spectrum

recently obtained at Yerkes Observatory, U.S.A. The majority of the bands recorded belong to the Herzberg system of O_2, although the $v' = 0$ progression is rather weak. Several other bands, not yet identified, appear in the spectrogram. D. R. BARBER

551.594.5 : 550.385

7922. Anomalous ionization in the upper atmosphere over the auroral zone during magnetic storms. M. SUGIURA, M. TAZIMA AND T. NAGATA. *Rep. Ionosphere Res. Japan*, **6**, 147–54 (*Sept.*, 1952).

The depth of penetration and the rate of ionization of protons of extra-terrestrial origin were determined on the basis of the model atmosphere proposed by Gerson. It was found that the energy of protons, which play an important part during magnetic storms, is several hundreds keV, or 1×10^9 cm/sec in velocity. The rate of ionization of protons of this energy has a pronounced maximum near the bottom edge of the range of penetration. The life time of the ionized state was found to range from a few minutes to ten seconds. The density of precipitating protons required to maintain the ionized state was roughly estimated at 1 proton/cm^3 or less, which can be considered as reasonable values. An explanation was proposed for the violent and rapid variations in magnetic field observed in and near the auroral zone. A.

551.594.7

7923. Direct measurement of the refractive index gradient of the air in the lower atmosphere. M. ELNESR. *C.R. Acad. Sci.* [*Paris*] **238**, 1440–2 (*March* 29, 1954) *In French.*

Short description of electrical apparatus employing Cu-constantan thermocouples separated vertically by 140 cm with the lower one 10 cm from the ground [see also Abstr. 2953 (1954)]. Results given compare favourably with those calculated. G. M. BROWN

BIOLOGY 57/59

577.15

7924. Mechanism of enzymatic actions. R. WURMSER. *Cahiers de Phys., No.* 47, 55–69 (*Jan.*, 1954) *In French.*

A general survey of the actions of enzymes is given. A reaction involving enzymes is considered to proceed via a complex containing the enzyme. If one assumes that the concentration of the complex is small with respect to that of the original compound, some reaction constants can be calculated. The existence of the complex is confirmed by the behaviour of haemoenzymes, which affect the spectrum of the reacting products, and also by inhibition phenomena. The constitution of enzymes is considered: all are proteins, some also containing a non-protein part, the coenzyme. Many, although containing the same coenzyme, act specifically on different substances. The efforts and methods to draw conclusions about the effective centre of the enzyme and its action are described. Stereochemical factors are often important, in the enzyme as well as in the compound on which it acts. Electrostatic and van der Waals' forces can also determine the formation of the complex. The activation energy of the reaction must be lowered by the enzyme. This is investigated and discussed. A. J. TAYLOR

577.15

7925. Factors governing the biosynthesis of enzymes. J. MONOD. *Cahiers de Phys., No.* 47, 70–84 (*Jan.*, 1954) *In French.*

See also preceding abstract. Here the way in which enzymes are formed is discussed. As many enzymes are formed by the same cells, the problem is in principle biological. Factors governing the synthesis can be either genetic or chemical. As example the formation of certain enzymes is discussed in detail. A. J. TAYLOR

577.21

7926. The processes of autosynthesis. J.-L. DESTOUCHES. *Cahiers de Phys., No.* 47, 36–54 (*Jan.*, 1954) *In French.*

The fundamental characteristic of life, the self-reproduction of genes or virus particles, is compared to catalysis and autocatalysis in chemistry. The author discusses various theories put forward by physicists, e.g. Jordan, Freska, Winter, Bohr and points out the need for physicists to apply the results of recent discoveries in theoretical physics to these difficult biological problems. J. IBALL

578.087.86

7927. A calorimeter for rapid determination of heat loss and heat production in laboratory animals. R. W. LAWTON, L. R. PROUTY AND J. D. HARDY. *Rev. sci. Instrum.*, **25**, 370–7 (*April*, 1954).

A rapid calorimeter of the gradient type, suitable for laboratory animals, has been built and tested. A thin gradient layer (0·015 in. woven glass tape) of relatively high thermal conductivity is used to line the walls of the calorimeter. The heat flow rate across the gradient layer is measured by means of 2152 copper-constantan thermal junctions wired in series. With an input of 1 kcal/hr, 83·26 μV output is obtained. Total response time of the instrument together with the animal holder and metabolic equipment in place is of the order of 10–12 min. Heat loss by vaporization is measured by electric hygrometer sensing elements. Heat production is determined by a continual analysis of oxygen consumption using a Pauling analyser. Heat loss, heat production, and rectal, skin, air, and wall temperatures are continuously recorded. Electric and alcohol calibrations and preliminary observations on monkeys are presented. The calorimeter should make possible critical experiments on thermoregulatory mechanisms of animals. A.

578.087.9

7928. Simple, automatic, continuous-recording respirometer. F. A. BROWN, JR. *Rev. sci. Instrum.*, **25**, 415–17 (*May*, 1954).

A new type of respirometer is described. The method involves a "diver" which is composed of a rigid respiratory chamber containing a CO_2 absorbent and an O_2-containing collapsible sack feeding O_2 into the chamber by way of a capillary tube. As O_2

is used by the organism in the respiratory chamber, replacement O_2 arrives from the collapsible sack thereby decreasing the buoyancy of the system. The change in buoyancy is recorded on a kymograph drum by an ink-recording spring scale. The method has been put in practice using 50 cm^3 soxhlet distilling flasks with rubber stoppers penetrated by 27-gauge hypodermic needles as the respiratory chamber and sections of Saran tubing with an O_2 capacity of 40–50 cm^3 attached to the stopper as the collapsible sacks. Recording spring scales with variable ranges from 2 to 20 g which have served satisfactorily for measuring natural variations in rates of O_2 consumption for certain small animals are described. A.

578.088.9

7929. A multicelled sample container for the rapid counting of P^{32} in blood. H. C. Lawson, E. S. Coleman and S. Adams. Note in *Rev. sci. Instrum.*, **25,** 397 (*April*, 1954).

The 0·5 cm^3 samples are counted through the thin window (37·6 mg/cm^2) of a vertical flat Perspex cell; the complete container consists of 12 cells. The area of the cell from which the radiation is counted is determined by a hole in the lead screen round the Geiger counter, so that accurate pipetting of the sample is not required. L. E. MUSSELL

578.089

7930. An automatic tool for opening embryonated eggs. T. Nadeje, J. Blum and F. L. Horsfall, Jr. *Rev. sci. Instrum.*, **25,** 293–4 (*March*, 1954).

With this, eggs can be opened at the rate of 60 or more per min. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.17

7931. An electronic cardiac defibrillator and pacemaker. R. K. McCombs, C. E. Herrod and R. S. Mackay. *Rev. sci. Instrum.*, **25,** 378–9 (*April*, 1954).

An instrument has been devised to stop ventricular fibrillation and to restore rhythmical beating of the heart in standstill. The instrument provides 60-cycle sinusoidal pulses continuously variable from 0 to 3 A in intensity and from 0·01 to 1·0 sec in duration. A single pulse may be delivered for defibrillation, or regularly repeating pulses, from 20 to 120 per min, may be delivered for instituting rhythmical beating of the arrested heart. The time intervals produced are quite independent of line voltage and tube changes. Suitable provision is made for the protection of the operator from accidental short circuit to ground. Clinical use of the instrument has been restricted to defibrillation, where it has proved successful. A.

612.84

7932. Review of problems of vision. L. Ronchi. *Atti Fond. Ronchi*, **8,** 293–319 (*Sept.–Oct.*, 1953) *In Italian.*

Covers papers published on vision in American, French, Italian and Scandinavian journals during April 1952–3. The review deals only with subjective work. R. A. WEALE

612.84

7933. Visibility of complex test objects. L. Ronchi. *Atti Fond. Ronchi*, **8,** 380–4 (*Nov.–Dec.*, 1953) *In Italian.*

This is a consideration of factors affecting the visibility of complex targets. R. A. WEALE

612.84 : 535.82

7934. Experiments with magnifying glasses. L. Ronchi and A. M. Ercoles. *Atti Fond. Ronchi*, **9,** 52–60 (*Jan.–Feb.*, 1954) *In Italian.*

The apparent magnification of an object as viewed through simple lenses (whose power P varied from 0·5–70 D) was measured as a function of P and the object distance. Tests were done both when the observer could and could not obtain other clues of the position of the image plane. The data agreed with a theoretical formula only in the former case; in the latter the apparent ("psychological") magnification was consistently very much greater than predicted. R. A. WEALE

612.84 : 536.521

The selection of observers for primary standard optical pyrometry. *See Abstr.* 7382

612.843.2

7935. Relationship between critical flicker-frequency and a set of low-frequency characteristics of the eye. H. de Lange Dzn. *J. Opt. Soc. Amer.*, **44,** 380–9 (*May*, 1954).

The results of measurements of the critical flicker frequency of the eye depending on both the average luminance of the test field and the time function of this luminance were recorded by plotting the "ripple ratio" r *v.* the critical frequency; r is defined as "amplitude of first Fourier component/average luminance" of the stimulus. It is shown that with constant average luminance the points observed for various time functions fit into one smooth curve which for low luminances is monotonous. At high luminances the curve shows a minimum for r, which is smaller than the threshold value of the foveal brightness discrimination ratio 1·35%, observed for a frequency $f = 1$ c/s. A.

612.843.3 : 628.972

7936. Visual factors in lighting. W. S. Stiles. *Illum. Engng*, **49,** 77–92 (*Feb.*, 1954).

A discussion, seriatim, of a large number of the visual factors which are of direct interest to the illuminating engineer. These include (*a*) the effect of brightness distribution and retinal illumination on ease of vision, (*b*) the relation between luminance (physical brightness) and visual sensation, (*c*) the roles played by the rods and cones respectively in vision at different levels of brightness, and the different mechanisms of cone vision, (*d*) the sensation of brightness by oblique vision, (*e*) the relative glaring effects of lights of different colours, (*f*) colour adaptation and colour rendering, (*g*) the relations between surround brightness, source brightness and discomfort glare. J. W. T. WALSH

612.843.31

7937. Variations in normal colour vision in relation to practical colour matching. F. L. Warburton. *Proc. Phys. Soc.* [*London*] *B*, **67,** 477–84 (*June*, 1954).

The influence of variations in colour vision on

matching a dyed pattern with one of a range of dichroic series has been observed for 250 normal observers. The results have been compared with the variations produced by a change in lighting for a single observer. The results have been related to the data of Wright on the variations in colour vision attributable to differences in pigmentation with which they are in close accord. The number of observers was sufficient for a statistically significant change in colour vision with age to be detected. This change corresponds to increased pigmentation and confirms the commonly held view that older people see redder than young. The bearing of the results on the selection of colour workers is discussed. A.

612.843.367

7938. Re-evaluation of the scattering theory of glare. G. A. Fry. *Illum. Engng*, **49**, 98–102 (*Feb.*, 1954).

Re-examines the theory that glare is due to the incidence on the retina of light scattered in the eye media. Assuming a scatter function which has a high predominance of forward scattering, and taking the amount of scatter as independent of wavelength, the author derives a formula for the illumination due to scattered light on the retina and shows that this can be brought into conformity with the accepted glare formulae of Stiles and Holladay.

J. W. T. WALSH

612.843.611

7939. Human reaction time during dark-adaptation. S. MacLeod and N. R. Bartlett. *J. Opt. Soc. Amer.*, **44**, 374–9 (*May*, 1954).

Reaction times of two subjects for different brief flashes are measured during the course of dark adaptation. Seven experimental conditions known to influence measures of dark adaptation are investigated. The results are discussed for their bearing on traditional psychophysical measures of threshold changes. A.

612.843.612

7940. Contrast threshold and luminance level according to the theory of sensory groupings. M. Aguilar, J. Oliva and J. Yunta. *An. Real. Soc. Españ. Fis. Quím.*, **49**(A) 331–40 (*Nov.–Dec.*, 1953) *In Spanish.*

This theory of vision [see also Abstr. 5194 (1953)] makes predictions of the luminance variation of the contrast thresholds, which were tested by five observers. A multiple test-field was used which facilitates the measurement of the threshold but renders the interpretation of the results more difficult. The results agree with the theory less badly than with other explanations. Suggestions are made of how the theory could be improved. R. A. WEALE

612.843.612

7941. Perception of brief variations in brightness. A. V. Luizov. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 5, 1063–5 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-199.

Flash-contrast A for white light was measured by four observers as a function of the flashing time t. The data A obey a $\log t$ relation better than a linear one. R. A. WEALE

612.843.621

7942. Theoretical interpretation of the curve relating field-size and absolute threshold. M. Aguilar, J. Oliva and A. Plaza. *An. Real. Soc. Españ. Fis. Quím.*, **49**(A) 325–30 (*Nov.–Dec.*, 1953) *In Spanish.*

Fournier's data presented in Madrid (1953) provide the basis for a speculation on the mechanism of retinal summation. [The references are faulty and inadequate.] R. A. WEALE

612.843.721

7943. Studies in binocular vision. I. The non-existence of Panum's fusion areas. Y. Le Grand. *Atti Fond. Ronchi*, **8**, 423–8 (*Nov.–Dec.*, 1953) *In French.*

This remarkable paper shows that single perception of two images of the same object can be explained without postulating Panum's fusion areas by considering the variation of visual acuity with retinal eccentricity. The author also shows that these areas have been described as elliptical because of a measurement artefact. Experiments, from which the size of Panum's areas was deduced, are reinterpreted on the basis of inaccuracy of fixation rather than fixation disparity between the two eyes. R. A. WEALE

612.843.721

7944. Studies in binocular vision. II. Luneburg's theory of visual space. Y. Le Grand. *Atti Fond. Ronchi*, **9**, 44–51 (*Jan.–Feb.*, 1954) *In French.*

An account is given of Luneburg's theory. Its predictions are compared with (other writers') experimental findings, and the disagreements between the theory and fact lead the author to the view that "Luneburg's theory is amusing. . . . It is doubtful whether any mathematical representation can describe the subjective visual universe." R. A. WEALE

612.843.721

7945. On the existence of nocturnal binocular convergence. A. Ivanoff and C. Bourdy. *C.R. Acad. Sci.* [*Paris*] **238**, 1537–9 (*April* 5, 1954) *In French.*

Convergence measurements were done on seven observers by a method to be published elsewhere. The luminance of the test object varied from 10^{-1} to 10^{-6} nits. At luminances lower than 10^{-2} to 10^{-3} nits non-hypermetropic observers were found to have near points reaching limiting values of 1·7–2·1D. Two hypermetropes had significantly farther near points at very low luminance levels. When the test-object was removed from 20 cm (5D) to 150 cm (0·7D), the values of the emmetropes increased, as the luminance was reduced, from about 0·8D to the respective limiting values found in the previous experiment. The results of the hypermetropes cannot be characterized. The results are correlated with other findings related to nocturnal vision. R. A. WEALE

612.844.4 : 534.22/.23

Acoustic properties of the refractive media of the eye. *See Abstr.* 7194

612.85 : 621.391

7946. Responding to one of two simultaneous messages. W. Spieth, J. F. Curtis and J. C. Webster. *J. Acoust. Soc. Amer.*, **26**, 391–6 (*May*, 1954).

Twenty operators were given a task which required

answering one of two simultaneous voice messages. The task was performed under a variety of conditions produced by combinations of four experimental "aid" variables: horizontal spatial separation of the sound sources, aural shaping filters which made the tone quality different in each channel, visual cues which indicated the channel about to call the operator and facilities to "pull down" a desired message from the initial source into a headphone or a loudspeaker near the operator's ear. It was found that the use of horizontal separation and/or the filtered messages greatly improved the operator's performance. Visual cues had no apparent effect on ability to answer the message except when used with pulldown facilities. The pulldown facilities aided the operator to some extent. Some speculations are advanced about the nature of recognizing and attending to a message in the presence of another message. A.

612.85 : 621.391

7947. Responding to both of two overlapping messages. J. C. WEBSTER AND P. O. THOMPSON. *J. Acoust. Soc. Amer.*, **26**, 396–402 (*May*, 1954).

Air control tower operators listened to test transmissions, consisting of speech intelligibility tests couched in aeroplane-tower phraseology, over four channels. Part of the time the messages of two channels overlapped each other and the degree of overlap was systematically varied. The task was to respond to all messages. The results showed a decrement in performance related directly to the amount of overlap, the leading message being understood better (unless it was considerably lower in intensity). For those parts of the message which had low informational content, the messages of the overlapping channel increased the total assimilated information per unit time above the total assimilated in the absence of the competing channel messages. A.

612.858.75

7948. Contribution to the study of the working of the ear, by the examination of response curves in monaural and binaural listening. R. CHOCHOLLE. *Acustica*, **4**, *No.* 1, 99–100 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Threshold improvement in binaural listening relatively to monaural listening cannot be explained by a purely statistical hypothesis. A study of monaural and binaural response curves shows that summation only takes place in higher centres. Summation of effects occurs proportional to power, not to pressure. If aleatory phenomena determined the threshold they would have to be numerous: about 30 to 40. A.

612.858.76

7949. Statistical study of monaural and binaural auditory thresholds. Interpretation of results. R. CHOCHOLLE. *Acustica*, **4**, *No.* 2, 341–50 (1954) *In French.*

To explain threshold improvement in binaural listening relative to monaural listening, two hypotheses may be put forward, one purely statistical, the other bearing upon summation in the nervous centres. Theoretical study of the hypotheses shows that it is possible to distinguish between them by comparing statistical response curves for monaural and binaural listening. This comparison shows that, for all observers and all frequencies tested, only the summation hypotheses can be maintained. A survey of response curves obtained with various differences in stimulation between the two ears proves that there occurs summation of effects proportional to power, hence to energy, i.e. possibly to the number of molecular shocks on the basilar membrane. It appears, in interpreting the very steep slope of response curves, that, if quantal phenomena determine threshold, they must be numerous: about 30 to 40 in fact. Threshold improvement seems not to vary with frequency in binaural listening, whatever differences in stimulation between the two ears there may be. A.

614.898

7950. Determination of the radiation hazards from a 1·5 MeV high voltage accelerator. K. AHNLUND. *Ark. Fys.*, **7**, *Paper* 13, 149–53 (1953).

The radiation intensities due to the 1·5 MeV cascade generator of the Nobel Institute have been measured at different positions. Both the X-ray and the fast-neutron distributions have been found and it is shown that no working rooms receive an excessive dose in the time for which they are likely to be occupied. J. H. FREMLIN

614.898

7951. Protection against the lethal effects of X-rays on the mouse by means of the 4-acylpyrogallols. A. LACASSAGNE, J.-F. DUPLAN AND N. P. BUU-HOÏ. *C.R. Acad. Sci.* [*Paris*] **238**, 1279–81 (*March* 22, 1954) *In French.*

These 4-substitued pyrogallols have great affinity for O_2. Injected intra-peritoneally into mice, the reduction of O_2 tension is shown to prolong life after total-body irradiation by X-rays. D. V. MABBS

615.837 : 534.321.9

7952. "Damage risk criteria" and "warning signals." W. A. ROSENBLITH AND T. F. HUETER. *J. Acoust. Soc. Amer.*, **26**, 453 (*May*, 1954).

Further remarks on the criteria previously discussed [Abstr. 4068 (1954)].

615.849

7953. Convergent beam irradiator. Apparatus for convergent beam irradiation with stationary or moving source. C. B. BRAESTRUP, D. T. GREEN AND J. L. SNARR. *Radiology*, **61**, 614–24 (*Oct.*, 1953).

A description is given of a unit housing a radiocobalt source in which the source can be moved readily over a section of a spherical surface with the beam pointing at the centre of the sphere. With the patient adjusted so that the tumour to be treated is at the centre of the sphere treatment fields for multiportal therapy are easily set up. The movements of the source over the surface by variable speed motors make it possible to accomplish a wide variety of rotation therapy techniques with either continuous or interrupted irradiation. The shielding of the equipment is such that a radiocobalt source giving 60 r per min at 1 metre can be accommodated. H. MILLER

615.849 : 621.327.3

7954. The generation of ultraviolet radiation for medical purposes. J. KERN. *Elektrotech. Z.* [*ETZ*] *B*, **6**, 67–72 (*March* 21, 1954) *In German.*

The u.v. spectrum is briefly discussed and the

medical significance of the different parts of it pointed out. Following a short reference to the open carbon arc, the development of the more modern high- and low-pressure Hg-vapour lamps is described in detail. The spectral distribution, power consumption, provision of auxiliary striking electrodes and of water cooling and the use of paraboloid reflectors are studied. Examples of standard models and special designs for use in dentistry and for blood irradiation are illustrated. The possible value of the recently developed Xe high-pressure lamp with its exceptionally wide spectrum is emphasized. Warning is given regarding the undesirable effects of excessive ozone generation and the risk of conjunctivitis through over-exposure. H. G. M. SPRATT

616–073 : 621.3.012.8 : 621.317.755

7955. Electrocardiography as a problem for modern engineering. H. E. HOLLMAN. *Trans Inst. Radio Engrs Prof. Group on Med. Electronics, No. PGME-1*, 1–26 (*Nov.*, 1953).

Electrical analogies comprising 2 or 3 relaxation oscillators can be made to give a close parallel to the physiological and electrical characteristics of the heart. It is shown that the electric vector of the heart, which rotates through nearly 360° in each cycle, may be determined from ordinary electrocardiograph data, and details are given of a "triograph" technique for displaying on a c.r.t. the locus of this vector. This information is more fundamentally related to heart function than standard 3-lead tracings, and may be of importance in clinical diagnosis. F. T. FARMER

616–073 : 621.389

7956. An electronic heart-beat recorder. E. VAN VOLLENHOVEN AND C. T. DE WIT. *Appl. sci. Res. B*, 3, *No.* 4–5, 293–6 (1953).

An apparatus for recording the heart-beats of persons at work is described. The input signal is obtained from a barrier layer photocell and a lamp at the ear-lobe. The signal is amplified by a differential amplifier with symmetrical input and feedback. A.

616–073.75 : 621.386.832

7957. Possibilities and limitations of image amplification. E. FENNER AND O. SCHOTT. *Z. angew. Phys.*, 6, *No.* 2, 88–95 (1954) *In German.*

Amplification of the fluorescent X-ray image is discussed comprehensively. Limitations due to physiology of the human eye, to statistical fluctuations in quanta incident on the screen, and problems of light intensity and contrast, are considered. Requirements of ideal image amplifiers, and technical arrangements of existing systems are described with diagrams and compared. The present-day position of X-ray image-amplification is summarized. Many references are given. D. V. MABBS

TECHNICAL MATERIALS 66/67

669 : 548.7 : 539.11

7958. The transition metals and their alloys. W. HUME-ROTHERY AND B. R. COLES. *Advances in Phys.*, 3, 149–242 (*April*, 1954).

A comprehensive review dealing with the following topics: Physical properties (crystal structure, elastic, thermal, magnetic), atomic and covalent radii, electron theory (general, magnetism, energy band structure, Pauling's ideas), alloys (solid solutions, intermediate compositions, dilute solid solutions of transition in other metals, theoretical models), alloys with aluminium, experiments of possible value in elucidating the structure of transition metals. 33 diagrams, 11 tables, 167 references. E. P. WOHLFARTH

679.5

7959. A mould for pressing plastic disks. K. H. STARK; R. HAYES. Notes in *J. sci. Instrum.*, 30, 341–2 (*Sept.*, 1953); 31, 149 (*April*, 1954).

PHOTOGRAPHY 77

77

7960. On an evaluation of the capacity of photography for information. M. G. FRACASTORO. *Atti Fond. Ronchi*, 8, 385–92 (*Nov.–Dec.*, 1953) *In Italian.*

By photography a large number of details and thus information can be registered in a brief time. The factors which combine to produce the registration and the limits set to the representation by diffraction and the photographic emulsion are considered. A practical example is discussed. S. WEINTROUB

771.31

7961. On the depth of focus of photographs. M. CZERNY. *Optik*, 11, *No.* 6, 291–5 (1954) *In German.*

A theoretical discussion which assumes that the final photograph has the same perspective as the original scene and that it gives the same resolution of detail as the direct view. The latter condition, namely that the eye can resolve down to 1′ of arc, is found to require a lens aperture of 4·6 mm at wavelength 5500 Å by consideration of the diffraction pattern of the image of a point. A formula is then derived for the depth of focus in terms of the wavelength and the object distance, and numerical values are given for various cases. S. T. HENDERSON

771.35

7962. The specification and measurement of the speed of high aperture cameras. P. LINDBERG. Letter in *Appl. sci. Res. B*, 3, *No.* 2, 145–6 (1953).

The definition of camera aperture as ratio of exposure necessary when photographing an object to exposure necessary when the object is printed in

contact has been experimentally determined. As the self-luminous object the opening in an enclosure giving a uniform brightness in all directions is employed. A. L. MACKAY

771.53 : 533.5

7963. Evacuating photographic materials for use in electron optical apparatus. J. H. REISNER. *Rev. sci. Instrum.*, **25**, 477–9 (*May*, 1954).

Vacuum systems containing photographic materials may be most rapidly pumped if the materials have been desiccated previously. The primary factors influencing pumping time are the degree of preliminary desiccation and the amount of resorption of water vapour during the transfer of the material from the desiccator to the vacuum apparatus. Desiccation may be achieved by the use of a drying agent, evacuation or the elevation of temperature. Resorption of water vapour may be minimized by rapid transfer of materials in tight containers from the desiccating means to the vacuum apparatus. A.

771.534

7964. Photographic effect of intermittence in a case of particular astrophysical interest. M. HACK. *Atti. Fond. Ronchi*, **8**, 353–8 (*Sept.–Oct.*, 1953) *In Italian.*

A peculiar case of photographic intermittence-effect which takes place when photographing stellar spectra is examined. The best method to arrive at a precise calibration of the spectrograms directly on the telescope or in the laboratory is discussed considering a similarity of the intermittence effect whether at the telescope with the Hertzsprung method, or in the laboratory. It is concluded that a calibration with a suitable device is preferable. A.

771.534.1

7965. Photographic sensitivity and chemical sensitization of emulsions. W. F. BERG. *J. photogr. Sci.*, **1**, 2–11 (*Jan.–Feb.*, 1953).

A review of various methods of chemical sensitization of photographic emulsion grains and of the likely underlying mechanism is preceded by a discussion of the philosophy behind the various approaches to an understanding of the photographic process. The methods of sensitization are those by the gelatin, by sulphur (and more particularly by sulphide ions), by reduction, by mercury treatment and by gold compounds. Mitchell's model of sensitization is described and it is concluded that this is to be regarded more as a useful working hypothesis leading to fresh experimental work than as a completely settled and generally accepted mechanism. A.

771.534.55

7966. Progress in physics of the developed image. E. W. H. SELWYN. *J. photogr. Sci.*, **1**, 60–3 (*March–April*, 1953).

A brief survey. 21 refs.

771.534.55 : 535.317.25

The resolving power of an "objective-emulsion" combination. *See Abstr.* 7258

771.535 : 548.7

7967. Alteration of the AgBr lattice on the formation of the latent image. W. WAIDELICH. *Naturwissenschaften*, **41**, *No.* 9, 210–11 (1954) *In German.*

Earlier publications report inconsistent results. Debye–Scherrer photographs have been made for AgBr from a film of a normal emulsion which had previously received varying exposures to X-rays or light. During the diffraction photographs the film was kept moving to minimize the extra exposure to X-rays. For exposures < those for max. blackening, the spacing of the 620 plane increased up to 0·2 XU, but further exposures reduced this gradually to zero and eventually a decrease of the original spacing was observed. S. T. HENDERSON

778.33

7968. Simplified autoradiography exposure calculation. W. W. WAINWRIGHT, E. C. ANDERSON, P. C. HAMMER AND C. A. LEHMAN. *Nucleonics*, **12**, 19–21 (*Jan.*, 1954).

Factors governing the suitability of particular radioisotopes for autoradiography are discussed briefly and a chart, for the calculation of exposure times for β-emitters of various half-lives, is given.

L. R. SHEPHERD

778.34 : 537.591

7969. On a mathematical model of a photographic emulsion. C. E. FRÖBERG. *Ark. Fys.*, **7**, *Paper* 42, 497–502 (1954).

A model of a photographic emulsion is given in tabular form. From this model tracks can be obtained similar to those formed by cosmic rays. The number of grains per unit length is computed under different assumptions. A method for obtaining corrections due to secondary high-energy δ-rays is sketched, all procedures being based on a simple Monte Carlo technique. A.

778.34

7970. On the relation between the energy and the number of grains for low energy tracks in photographic emulsions. J. PNIEWSKI. *Acta phys. Polon.*, **11**, *No.* 3–4, 430–2 (1951–52).

The relation between the energy and the number of grains at low energies for Ilford electron-sensitive emulsion G5 was investigated. The observations were extended over energies from 37·1 keV down to 4·2 keV. A good separation of joined or overlapping grains was achieved by resoaking the emulsion before microscopic examination. A.

778.34

7971. Properties of a new nuclear track emulsion of the Agfa K2 plate. K. LANIUS. *Z. wiss. Photogr.*, **48**, *No.* 10–12, 243–62 (1953) *In German.*

Range-energy curves calculated from the composition of the emulsion show agreement with measurements on α's from Th decay and p's from $N^{14}(n,p)C^{14}$. Grain-density v. energy-loss characteristics are compared with other emulsions. The limit of sensitivity lies near 80 keV for electrons.

W. J. SWIATECKI

778.34

7972. Introduction of fine particles of a substance into the emulsion of the thick-emulsion photographic plates. ZH. S. TAKIBAEV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 229–32 (1953) *In Russian.*

The method described in Abstr. 5101 (1950) is believed by the author to be suitable for the accurate determination of the spatial distribution of the centres of nuclear fission in an emulsion. However, since the fine particles are introduced into the emulsion when

the latter is being spread, it becomes necessary to examine the whole volume of the emulsion, which makes the method very cumbersome. For investigation of the interaction of cosmic rays with the nuclei of different atoms, the author suggests introducing fine spheroidal particles of the respective substance, obtained by electric sparking, and discusses several methods of doing it. F. LACHMAN

778.34

7973. Insertion of a thin filament into a photographic emulsion for the purpose of investigating nuclear fission. ZH. S. TAKIBAEV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 233–6 (1953) *In Russian.*

Instead of sandwiching a metal foil between two emulsions [see e.g. Abstr. 5544 (1951)], the author uses a thin (30–50 μ) metal filament which is removed before the chemical treatment of the plate. The scanning is done along the trace of the filament. [See also Abstr. 8182 (1951), 3186 (1952).] F. LACHMAN

778.34

7974. Method of inserting thin filaments into thick-emulsion photographic plates. O. N. MILLER AND A. A. SIROTINSKAYA. *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 237–9 (1953) *In Russian.*

See preceding abstract. Describes another technique of inserting thin (10 and 30 μ) W wires between two emulsion layers. The deformation in the emulsion, due to indentation by the filament, does not extend beyond 20 μ for 10 μ filaments. F. LACHMAN

778.34

7975. Nuclear emulsion technique. A review of progress 1948–1953. C. WALLER. *J. photogr. Sci.*, **1**, 41–54 (*March–April*, 1953).

A brief survey of all aspects, including special techniques and applications. 83 refs.

778.34

7976. Measurements of the effects of moisture in nuclear track emulsion. A. J. OLIVER. *Rev. sci. Instrum.*, **25**, 326–30 (*April*, 1953).

In order to answer a number of specific questions, thickness and density measurements were made on Ilford nuclear track emulsions before and after processing. Measurements were made as equilibrium was approached under various conditions of ambient relative humidity. Thickness measurements were made with a modified dial micrometer. Volume measurements were made by weighing plates immersed in carbon tetrachloride. A special study of plates stored in a vacuum was carried out. The washing time was found to have an important effect on the shrinkage factor. The data obtained are presented in a number of tables and graphs. The theory of water diffusion in emulsion has been appended by W. H. Barkas, and the emulsion constants evaluated from the experimental data. Attention is directed to the very long characteristic diffusion times implied for thick emulsions. A.

778.34

7977. On the improvement of nuclear emulsion technique. G. MARGUIN AND M. MAITROT. Letter in *J. Phys. Radium.* **15**, 123–4 (*Feb.*, 1954) *In French.*

A brief account is given of attempts to regain the loss in sensitivity of G5 nuclear emulsions due to latent image eradication by the high humidity treatment described by Albouy and Farragi [Abstr. 9223 (1951)]. A. C. COATES

778.34 : 537.591

7978. A punched card system of recording of events in nuclear emulsion work. S. J. GOLDSACK AND D. HIRSCHBERG. Letter in *Nuovo Cimento*, **11**, 100–2 (*Jan.*, 1954).

The cards have a double row of holes punched round the edges and a certain number of these holes, appropriate to the particular type of event, are cut away to the edge. Events of a chosen type can be selected by passing knitting needles horizontally through the stack of cards through the relevant holes. H. ELLIOT

778.34 : 539.165

7979. Intensification of the latent photographic image produced by beta-rays. K. ZUBER. *Rev. Fac. Sci. Univ. Istanbul A*, **18**, 198–202 (*April*, 1953).

Experiments with Kodak *NT* 2*A* nuclear track plates show that the photographic action of β-rays from RaD, Co^{60} and U_3O_8 sources can be intensified by a post-exposure to light. The nature of this light, as also of the developer, is of importance. The fact is explained by Berg's hypothesis of the latent sub-image. It is shown that fading exists for the latent sub-image. A pre-exposure gives no intensification. A.

778.34 : 539.27

7980. Nuclear emulsions for electron microscopy. J. J. COMER AND S. J. SKIPPER. *Science*, **119**, 441–2 (*April* 2, 1954).

A method is described for the production of nuclear particle tracks from radioactive mineral grains in an emulsion thin enough for observation in the electron microscope. The emulsion is spread over a Formvar-coated glass slide: the radioactive grains are either mixed with the emulsion gel or dusted on after spreading. The emulsion is stripped in a Formvar solvent, after exposure and processing, and mounted on an electron microscope specimen grid. An emulsion thickness of 0·2 μ is used. The mineral grains can be identified by the small area electron diffraction technique. M. E. HAINE

778.34 : 77.023.4

7981. Techniques for processing thick nuclear emulsions. B. STILLER, M. M. SHAPIRO AND F. W. O'DELL. *Rev. sci. Instrum.*, **25**, 340–8 (*April*, 1954).

Techniques are described for the "eradication" and processing of thick electron-sensitive nuclear emulsions, and for handling "pellicles." 400 μ and 600 μ emulsions, eradicated by a method which preserves their sensitivity to minimum-ionization particles, exhibit marked reduction in track distortion, as well as in background. A modified procedure for uniform development of thick emulsions by the temperature-cycling method gives a favourable ratio of grain density to background. Countermeasures against stripping of thick emulsions from their glass base have proved efficacious over a 3 yr period. A stack of emulsions without glass support ("pellicles") provides a large sensitive volume in which tracks can be readily followed from one layer to the next. The lateral swelling ($\sim$ 25%) during processing, which discouraged the application of this technique, was overcome by the authors in 1951. They evolved a successful method

for mounting thick, stripped emulsions on to glass after exposure, but prior to processing, so that the pellicles can be developed as ordinary plates. Since then, additional experience has been gained in the application of pellicle stacks to high-energy physics. These procedures lead to emulsions free from lateral swelling, free from blistering, and characterized by a level of distortion sufficiently low to permit multiple scattering measurement even on fairly "stiff" tracks. The advantages and limitations of this technique, its possible applications, details of the mounting procedure, and methods of following tracks from layer to layer are discussed. A.

778.37

7982. High speed photography. G. A. JONES. *New York: John Wiley and Sons* (1952) 311 *pp.*

Review in *J. Opt. Soc. Amer.*, **44**, 257 (*March*, 1954).

778.37

7983. Fast multiple frame photography. J. S. COURTNEY-PRATT. *J. photogr. Sci.*, **1**, 21–40 (*Jan.–Feb.*, 1953).

A new principle has been applied to the optical systems of cameras so that series of photographs can be recorded at high speed without complex equipment. A plate embossed with a large number of small lenses is used to dissect the picture into small elements. These are all recorded simultaneously on a plate, but each element is separated from its neighbours by a distance that is large compared with the size of the element. Many successive pictures may be similarly dissected and recorded on the same plate interlaced with the others. The displacement of successive images with respect to the plate need only be as great as the width of a single picture element. The displacement is produced by altering the direction in which light falls on the lenticular plate, and this alteration may be achieved mechanically or optically. Using the simplest mechanical arrangement series of 200 photographs have been taken at 50 000 per second of objects that are self-luminous or that are separately illuminated. In each picture there are 40 000 picture elements—a resolution of 200 lines across the field in each dimension. For transparence or silhouette photography mechanically moving parts can be entirely eliminated. The displacement of the picture elements for separation of the individual frames is achieved by movement of the light source. In some forms of the apparatus the source of light is the luminous spot of a cathode-ray tube. Series of 200 pictures have been recorded at 200 000 per second. The exposure time and the rate of taking pictures can be independently controlled. Synchronization with the phenomenon is simple. In other forms of the apparatus a short trail of lead azide was used as a moving source of light. Twenty pictures were recorded at 4 000 000 per second. The cameras can all be used to unscramble the composite record for slow motion viewing and for conventional printing of individual pictures. It has been possible to construct simple apparatus which may be used in any one of the ways described. It is a versatile and powerful weapon for the attack of a wide range of physical problems. A.

778.37 : 538.613

7984. On the application of the Faraday effect to the development of a high-speed repetitive recording technique and to flash-tube photography. D. ELLE. *Z. angew. Phys.*, **6**, *No.* 2, 49–54 (1954) *In German.*

The paper gives an account of experimental methods in high-speed photography, using exposure times varying down to about 8 μsec with a shutter opening time of about 2 μsec. Flint glass may be used to give the Faraday-effect shutter, and circuits for providing the current pulse in the solenoid are described. Some photographs are given, showing the bursting of diaphragms, tubes, etc. J. D. CRAGGS